

AD

AD-E400 923

SPECIAL PUBLICATION ARLCD-SP-82004

## HIGH SPEED METAL REMOVAL

TECHNICAL  
LIBRARY

RICHARD F. PUGH  
JONES & LAMSON DIVISION  
TEXTRON CORPORATION  
SPRINGFIELD, VT 05156

RAYMOND F. POHL  
PROJECT ENGINEER  
ARRADCOM

OCTOBER 1982



US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND  
LARGE CALIBER  
WEAPON SYSTEMS LABORATORY  
DOVER, NEW JERSEY

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

The citation in this report of the names of commercial firms or commercially available products or services does not constitute official endorsement by or approval of the U.S. Government.

Destroy this report when no longer needed. Do not return to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Special Publication ARLCD-SP-82004	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle)  HIGH SPEED METAL REMOVAL		5. TYPE OF REPORT & PERIOD COVERED Final January 1981 to June 1982
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Richard F. Pugh Jones & Lamson Division, Textron Corporation Raymond F. Pohl, ARRADCOM, Project Engineer		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Jones & Lamson Division Textron Corporation Springfield, VT 05156		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  MMT-5806738
11. CONTROLLING OFFICE NAME AND ADDRESS ARRADCOM, TSD STINFO Div (DRDAR-TSS) Dover, NJ 07801		12. REPORT DATE October 1982
		13. NUMBER OF PAGES 326
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) ARRADCOM, LCL Munitions Systems Division (DRDAR-LCU-M) Dover, NJ 07801		15. SECURITY CLASS. (of this report)  Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES This project was accomplished as part of the U.S. Army's Manufacturing Methods and Technology Program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in production of Army materiel. (cont)		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) MMT-High speed machining Metal removal Tool wear		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  Four types of steel (AISI 1340, 4140, 4340, and HF-1) which are commonly used in large caliber projectile manufacture were machined at different hardness ranges representing the as-forged and the heat-treated condition with various ceramic tools using ceramic coated tungsten carbide as a reference. Results show that machining speeds can be increased significantly over current practice using the present available tooling.		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

18. SUPPLEMENTARY NOTES (cont)

This report was prepared under contract DAAK10-80-C-0029.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



## CONTENTS

Introduction	1
Experimental Procedure	2
The Process	2-4
Materials	4-5
Discussion of Test Results	8
1340 Material - M483 Projectile Bodies - Roughing Cuts - 207 to 286 Brinell Hardness (16 to 29 RC)	8
1340 Material - M483 Projectile Forgings - Finishing Cuts - 302 to 364 Brinell Hardness (31/38 RC)	13-14
4140 Material - M509 Projectile Forgings - Roughing Cuts - 170 to 217 Brinell Hardness (8/18 RC)	19-20
4140 Material - M509 Projectile Forgings - Finishing Cuts - 364 to 418 Brinell Hardness (38/43 RC)	25
4340 Material - M549 Motor Bodies - Roughing Cuts - 217 to 321 Brinell Hardness (18 to 34 RC)	30-31
4340 Material - M549 Motor Bodies - Finishing Cuts - 363 to 415 Brinell Hardness (39 to 44.5 RC)	37-39
HF-1 Material - XM795 Projectile Forgings - Roughing Cuts - 255/302 Brinell Hardness (25/31 RC)	44-45
HF-1 Material - XM795 Projectile Forgings - Finishing Cuts - 286 to 387 Brinell Hardness (29/41 RC)	51-52
Conclusions	295
Recommendations	295
Appendixes	
A Chemical Composition and Micrographs of Materials	295B
B Chip-Breaker Design	304A
Distribution List	309

## TABLES

1	Summary of Test Results	6
2	Comparison of Test Results	7
3	Life-Line Data for AISI 1340 "roughing" cuts	60
4-10	Tool Wear-Land Chart Data for AISI 1340-"roughing" cuts, 570 Ceramic Coated Carbide	61-67
11-20	Tool Wear-Land Chart Data for AISI 1340 - "roughing" cuts; G-30 Ceramic	68-77
21-24	Tool Wear-Land Chart Data for AISI 1340 - "roughing" cuts; G-10 Ceramic	78-81
25	Tool Load Data for AISI 1340 "roughing" cuts	82
26-27	Life-Line Data for AISI 1340 "finishing" cuts	85-86
28-31	Tool Wear-Land Chart Data for AISI 1340-"finishing" cuts; 570 Ceramic Coated Carbide	87-90
32-35	Tool Wear-Land Chart Data for AISI 1340 - "finishing" cuts; G-30 Ceramic	91-94
36-39	Tool Wear-Land Chart Data for AISI 1340 - "finishing" cuts; G-10 Ceramic	95-98
40	Tool Load Data for AISI 1340 "finishing" cuts	99
41	Life-Line Data for AISI 4140 "roughing" cuts	103
42-56	Tool Wear-Land Chart Data for AISI 4140 - "roughing" cuts; 570 Ceramic Coated Carbide	104-118
57-58	Tool Wear-Land Chart Data for AISI 4140 - "roughing" cuts; G-10 Ceramic	119-120
59-65	Tool Wear-Land Chart Data for AISI 4140 - "roughing" cuts; G-30 Ceramic	121-127
66	Tool Load Data for AISI 4140 "roughing" cuts	128
67	Life-Line Data for AISI 4140 "finishing" cuts	131

68-72	Tool Wear-Land Chart Data for AISI 4140 - "finishing" cuts; 570 Ceramic Coated Carbide	132-136
73-76	Tool Wear-Land Chart Data for AISI 4140 - "finishing" cuts; G-30 Ceramic	137-140
77-83	Tool Wear-Land Chart Data for AISI 4140 - "finishing" cuts; G-10 Ceramic	141-147
84	Tool Load Data for AISI 4140 "finishing" cuts	148
85	Life-Line Data for AISI 4340 "roughing" cuts	152
86-102	Tool Wear-Land Chart Data for AISI 4340 - "roughing" cuts; 570 Ceramic Coated Carbide	153-169
103-117	Tool Wear-Land Chart Data for AISI 4340 - "roughing" cuts; G-30 Ceramic	170-184
118-121	Tool Wear-Land Chart Data for AISI 4340 - "roughing" cuts; G-10 Ceramic	185-188
122	Tool Load Data for AISI 4340 "roughing" cuts	189
123	Life-Line Data for AISI 4340 "finishing" cuts	193
124-132	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; 570 Ceramic Coated Carbide	194-202
133-136	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; G-10 Ceramic	203-206
137-138	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; G-30 Ceramic	207-208
139-147	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; G-10 Ceramic	209-217
148-154	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; G-30 Ceramic	218-224
155-160	Tool Wear-Land Chart Data for AISI 4340 - "finishing" cuts; NTK Ceramic	225-230
161	Tool Load Data for AISI 4340 "finishing" cuts	231

162-163	Life-Line Data for HF-1 “roughing” cuts	234-235
164-178	Tool Wear-Land Chart Data for HF-1 “roughing” cuts; 570 Ceramic Coated Carbide	236-250
179-183	Tool Wear-Land Chart Data for HF-1 “roughing” cuts; G-30 Ceramic	251-255
184-190	Tool Wear-Land Chart Data for HF-1 “roughing” cuts; G-10 Ceramic	256-262
191	Tool Load Data for HF-1 “roughing” cuts	263
192-193	Life-Line Data for HF-1 “finishing” cuts	267-268
194-199	Tool Wear-Land Chart Data for HF-1 “finishing” cuts; 570 Ceramic Coated Carbide	269-274
200-202	Tool Wear-Land Chart Data for HF-1 “finishing” cuts; KC-910 Ceramic Coated Carbide	275-277
203-209	Tool Wear-Land Chart Data for HF-1 “finishing” cuts; G-30 Ceramic	278-284
210-215	Tool Wear-Land Chart Data for HF-1 “finishing” cuts; G-10 Ceramic	285-290
216	Tool Load Data for HF-1 “finishing” cuts	291

## FIGURES

1	Life-Lines for 570 Ceramic Coated Carbide and G-30 Ceramic on AISI 1340, "roughing" cuts	9
2-3	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-1340 "roughing" cuts	10-11
4	Wear-Land Curves for G-30 Ceramic on AISI 1340, "roughing" cuts	12
5	Life-Lines for 570 Ceramic Coated Carbide, G-10 and G-30 Ceramic on AISI-1340 "finishing" cuts	15
6	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-1340 "finishing" cuts	16
7	Wear-Land Curves for G-30 Ceramic on AISI-1340, "finishing" cuts	17
8	Wear-Land Curves for G-10 Ceramic on AISI-1340, "finishing" cuts	18
9	Life-Lines for 570 Ceramic Coated Carbide and G-30 Ceramic on AISI-1340 "roughing" cuts	21
10-11	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-4140 "roughing" cuts	22-23
12	Wear-Land Curves for G-30- Ceramic on AISI-4140, "roughing" cuts	24
13	Life-Lines for 570 Ceramic Coated Carbide, G-10, and G-30 Ceramic on AISI 4140 "finishing" cuts	26
14	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-4140 "finishing" cuts	27
15	Wear-Land Curves for G-30 Ceramic on AISI-4140, "finishing" cuts	28
16	Wear-Land Curves for G-10 Ceramic on AISI-4140, "finishing" cuts	29
17	Life-Lines for 570 Ceramic Coated Carbide G-10, and G-30 Ceramic on AISI-4340 "roughing" cuts	32

18	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-4340 "roughing" cuts	33
19	Wear-Land Curves for G-30 Ceramic on AISI-4340, "roughing" cuts	34
20	Wear-Land Curves for G-10 Ceramic on AISI-4340, "roughing" cuts	35
21	Tool Load Chrts and Cross Section of M-549 Motor Body showing changes in tool loads as cut progresses thru part.	36
22	Life-Lines for 570 Ceramic Coated Carbide and NTK Ceramic on AISI-4340 "finishing" cuts	40
23	Wear-Land Curves for 570 Ceramic Coated Carbide on AISI-4340 "finishing" cuts	41
24	Wear-Land Curves for NTK Ceramic on AISI-4340, "finishing" cuts	42
25	Photographs showing Wear-Lands on Rear of Nose Radius	43
26	Life-Lines for 570 Ceramic Coated Carbide, G-10 and G-30 Ceramic on HF-1, "roughing" cuts	46
27	Wear-Land Curves for 570 Ceramic Coated Carbide on HF-1 "roughing" cuts	47
28	Wear-Land Curves for G-10 Ceramic on HF-1, "roughing" cuts	48
29	Wear-Land Curves for G-10 Ceramic on HF-1, "roughing" cuts	49
30	Photos showing Cracking of Nose Radius and Top Rake Surfaces G-10 Ceramic Inserts	50
31	Life-Lines for KC-910 Ceramic Coated Carbide, G-10 and G-30 Ceramic on HF-1, "finishing" cuts	53
32-34	Wear-Land Curves for 570 Ceramic Coated Carbide on HF-1 "finishing" cuts	54-56

35	Wear-Land Curves for KC-910 Ceramic Coated Carbide on HF-1 “finishing” cuts	57
36	Wear-Land Curves for G-30 Ceramic on HF-1, “finishing” cuts	58
37	Wear-Land Curves for G-10 Ceramic on HF-1, “finishing” cuts	59
38	Tool Load Charts - AISI-1340 “roughing”, 570 Ceramic Coated Carbide	83
39	Tool Load Charts - AISI - 1340 “roughing”, G-30 Ceramic	84
40	Tool Load Charts - AISI-1340 “finishing” 570 Ceramic Coated Carbide	100
41	Tool Load Charts - AISI 1340 “finishing”, G-30 Ceramic	101
42	Tool Load Charts - AISI - 1340 “finishing”, G-10 Ceramic	102
43	Tool Load Charts - AISI - 4140 “roughing”, 570 Ceramic Coated Carbide	129
44	Tool Load Charts - AISI - 4140 “roughing”, G-30 Ceramic	130
45	Tool Load Charts - AISI - 4140 “finishing”, 570 Ceramic Coated Carbide	149
46	Tool Load Charts - AISI - 4140 “finishing”, G-30 Ceramic	150
47	Tool Load Charts - AISI - 4140 “finishing”, G-10 Ceramic	151
48	Tool Load Charts - AISI - 4340 “roughing”, 570 Ceramic Coated Carbide	190
49	Tool Load Charts - AISI-4340 “roughing”, G-10 Ceramic	191
50	Tool Load Charts - AISI - 4340 “roughing”, G-30 Ceramic	192 <sup>1</sup>
51	Tool Load Charts - AISI - 4340 “finishing”, 570 Ceramic Coated Carbide	232

52	Tool Load Charts - AISI - 4340 "finishing" - NTK Ceramic	233
53	Tool Load Charts - HF-1 "roughing" - 570 Ceramic Coated Carbide	264
54	Tool Load Charts - HF-1 "roughing" - G-10 Ceramic	265
55	Tool Load Charts - HF-1 "roughing" - G-30 Ceramic	266
56	Tool Load Charts - HF-1 "finishing" - KC-910 Ceramic Coated Carbide	292
57	Tool Load Charts - HF-1 "finishing" - G-10 Ceramic	293
58	Tool Load Charts - HF-1 "finishing" - G-30 Ceramic	294



## INTRODUCTION

The manufacture of artillery projectiles requires large quantities of turning equipment which operate with spindle speeds of approximately 400 to 500 RPM. Removing metal at these speeds requires large quantities of equipment to accomplish a particular machining operation. The basic tooling common to the turning equipment used in projectile manufacture is tungsten carbide, either plain or coated with various materials to enhance tool life. The nature of the cutting tools dictates that moderate cutting speeds be used in order to obtain a reasonable useful life.

The objective of this investigation was to determine the metal cutting characteristics of the newer tools available on the current market and to evaluate their performance in comparison with conventional tools. During this study four different steels commonly used in projectile manufacture were machined in each of two hardness ranges using the conventional tools as a reference and the tools under study for comparison with the reference. The steels used were AISI 1340, 4140, 4340, and HF-1, which were machined in the as-forged and heat-treated condition. The conditions of surface speed, feed, and tool geometry which affect tool life were determined and recorded.

## EXPERIMENTAL PROCEDURE

### THE PROCESS

The projectile bodies were chucked in the dynamometer lathe with the end supported by a live center mounted in the hexagon turret. The turning cuts were taken on the dynamometer lathe, using the dynamometer output as a guide to tool wear-rate. The surface speed, in feet per minute, was adjusted using a hand-held tachometer on the uncut diameter.

A cut of proper depth, 0.100 inches for "roughing" cuts and 0.050 inches for "finishing" cuts, was taken for a predetermined length. After the cut ended, the wear-land of the insert was then measured and recorded. The values recorded were the maximum wear-land, whether occurring on the flank or on the nose radius of the insert. For these tests, only one cutting edge per insert was used. Using this technique, manufacturing variables among inserts were represented in these tests. The tool holsters for these tests were all  $0^\circ$  lead angles, except where noted.

The diameter of the turned portions and the lengths of cuts were measured. The circumference was calculated and multiplied by the length of turn in inches, which provide a value of square inches of machined surface. This value, along with the wear-land of the particular cut, provided a point to plot on a curve of wear-land in inches versus machined surface in square inches. The surface speed in feet per minute and the feed rate in inches per revolution were held constant throughout all tests, for any particular curve. Comparison of the curves for different materials, show that the maximum, usable wear-land varied with the material under study, and one cannot arbitrarily select a useable tool life value for wear-land, without constructing a wear-land versus machined surface curve for the material under study.

Cuts were repeated and their values were used to plot a curve, until the curve shows imminent failure or until the wear-land has reached a predetermined value for tool life comparison. When conducting some tests the machined surface was improper for direct tool-life comparison. When these conditions occurred, the cutting parameters were changed to yield the same reference machined surface for comparison of tool life.

These curves of wear-land in inches versus square inches of machined surface will give the value of a point on a life-line plotted on a log-log chart of surface speed versus square

inches of machined surface. The point is derived from the number of square inches of machined surface for a specific speed at a predetermined wear-land of the insert. Plotting the data for various surface speeds results in the tool life line for this material, applicable to any surface speed. However, in order for a point to be used for plotting on the tool life-curve, two curves on the wear-land versus machined area were plotted to assure confidence in data. This was the procedure used except in the case of 4340, where there was insufficient material for multiple testing.

Tool wear was the only factor considered in determining tool-life for these tests. Whenever tool breakage occurred, which is a non-predictable failure caused by many factors, the machining parameters were adjusted to avoid breakage under the test conditions. The machining conditions established in these tests should give equal or better results on production machines.

This effort covered the application of ceramic-coated carbide and hot and cold-press ceramic inserts. When using ceramic inserts, it is imperative that tool holders specifically designed for use with ceramic inserts be used. Since ceramic inserts are generally thick, because of mechanical strength limitations, the tool holder should have a deep pocket. A thick shim should be provided and held in place by a screw to prevent movement. It is important that the shim have surfaces ground flat and parallel. The pocket of the holder should be flat to assure good support for the shim and insert. The top clamp should be large enough to apply the adequate restraining load to prevent motion of the insert, and should also have a low profile so chip-flow is not impeded.

The edge preparation of a ceramic insert is of paramount importance. For "roughing" cuts, the insert should have a well honed edge. The inserts should be cam-ground so that the nose radius blends with the sides of the insert. If the inserts are not cam-ground, there will be a line where the nose radius joins the sides of the insert. This junction will result in uneven wear on the flank of the insert. All surfaces should have good finishes so the grind marks are not present to propagate cracks. Care must be exercised when clamping ceramic inserts in the tool holders. To prevent chipping the inserts and pocket of the holder must be clean and free of chips and dust.

When using ceramic inserts, it is preferable to enter the work-piece from a chamfer, or to reduce the feed-rate for the first few revolutions to avoid excessive initial tool loading shock.

Special chip-breakers, in some application, may be necessary for good chip control. The chips should be broken into small segments and be guided away from the edges of the inserts so chipping of the insert will not occur. Appendix A describes some fundamentals of chip breaker design used at Jones & Lamson.

The tool life-lines of the four materials at two hardness levels, included in the text, show the effect of surface speed on tool-life for the tool geometry and work-piece combination. As the negative slope of this line decreases, the effect of surface speed becomes less critical on tool-life, but as the slope increases, and becomes more perpendicular, the effect of surface speed is more critical on tool life.

The area in square inches of machined surface per cutting edge is an economic consideration. In this study the surface speed, which would yield 2500 square inches of machined surface at a specific wear land was determined.

To use these life-line charts, the desired tool-life must first be determined and from the chart, the proper cutting speed and feed is found for that particular material. The tool-wear land listed on the life-line charts is the maximum value that should be used. A greater tool wear land would only result in accelerated non-uniform tool wear with very little increase in machined surface. This can be observed in the machined surface versus wear-land curves for the material and condition used.

### **Materials**

The workpiece materials, in the "as forged" conditions for the tests, were as follows:

<b>Materials</b>	<b>Part</b>	<b>Hardness (as forged)</b>
1340	M-483 Projectile Forging	207/286 BHN (16/29 Rc)
4140	M-509 Projectile Forging	170/217 BHN (8/18 Rc)
4340	M-549 Motor Bodies	217/321 BHN (13/34 Rc)
HF-1	XM-795 Projectile Forging	255/302 BHN (25/31 Rc)

Chemical and metallographic analysis of the four materials were done by Massachusetts Materials Research Inc., West Boylston, Mass. and are shown on page 296. After the projectiles were hardened, samples were taken, and photomicrographs of these samples are on pages 297 to 304.

The cutting tests for "roughing cuts" were taken on the above materials at depth of cut of approximately 0.100 inches using only one cut per projectile. All roughing cuts were taken through the forging scale. The projectiles were then heat-treated, and the resulting hardnesses are as follows:

Materials	Hardness
1340	302/364 BHN (31/38 Rc)
4140	364/418 BHN (38/43 Rc)
4340	363/415 BHN (39/44.5 Rc)
HF-1	286/387 BHN (29/41 Rc)

When checking the hardness of the parts for machining the "finish" cuts, it was found that the flat filed for the hardness check should not be put on the area to be turned. The depth of the flat was enough to cause erratic load readings from the dynamometer and may have been a source of unexplained breakage.

The cutting data compiled from these tests are shown in Table 1, page 6, and are compared in Table 2, page 7 with the data obtained in the first part of the study. For "roughing" cuts, the feed rate had to be lowered to be reliable. The higher feed rates were tried but did not give consistent results. When using ceramic inserts, a feed-rate of .022 inches per revolution was not feasible but when lowered to .015 inches per revolution, the results were very consistent. The results in Table 1 and 2 are compared using the Production Index which is obtained by finding the largest product of surface speed in feet per minute and feedrate in inches per revolution. The production index is a number that is used for comparing one set of cutting conditions to another, on the same operation and is directly proportional to the metal removal rate.

TABLE 1: Summary of Test Data

Material	Ceramic-Coated Carbide				"Roughing" Cuts				Hot Press G-10 Ceramic			
	SFM	Feed	Prod. Index		SFM	Feed	Prod. Index		SFM	Feed	Prod. Index	
1340	630	.025	15.8		920	.015	13.8		---	---	---	
4140	550	.025	13.8		830	.015	12.5		---	---	---	
4340	430	.022	9.5		720	.015	10.8		750	.015	11.3	
HF-1	410	.022	9.0		640	.015	9.6		600	.015	9.0	
					"Finishing" Cuts							
1340	460	.015	6.9		700	.015	10.5		670	.015	10.0	
4140	360	.015	5.4		660	.015	9.9		600	.015	9.0	
4340	300	.015	4.5		---	---	---		300	.011	3.3	
HF-1	360	.011	4.0		590	.011	6.5		610	.011	6.7	

TABLE 2: Comparison of Test Data

Material	“Roughing” Cuts											
	Ceramic-Coated Carbide			Cold-Press Ceramic								
	Previous Study <sup>1</sup>		Current Study	Previous Study <sup>1</sup>		Current Study						
	SFM	Feed Index	Prod.	SFM	Feed Index	Prod.	SFM	Feed Index	Prod.	SFM	Feed Index	Prod.
1340	700	.025	17.5	630	.025	15.8	830	.022	18.3	920	.015	13.8
4140	360	.033	11.9	550	.025	13.8	760	.022	16.7	820	.015	12.3
4340	400	.033	13.2	430	.022	9.5	750	.022	16.5	760	.015	11.4
HF1	420	.022	9.2	410	.022	9.0	470	.022	10.3	640	.015	9.6

	“Finishing” Cuts											
	Ceramic-Coated Carbide			Cold-Press Ceramic								
	Previous Study <sup>1</sup>		Current Study	Previous Study <sup>1</sup>		Current Study						
	SFM	Prod.		SFM	Prod.		SFM	Prod.				
	Feed Index	Index	Feed Index	Feed Index	Index	Feed Index	Feed Index	Index				
1340	470	.015	7.1	460	.015	6.9	660	.015	9.9	700	.015	10.5
4140	255	.015	3.8	360	.015	5.4	450	.015	6.8	660	.015	9.9
4340	180	.015	2.7	300	.015	4.5	250	.015	3.8	300	.011	3.3
HF.1	340	.011	3.7	370	.011	4.1	590	.011	6.5	590	.011	6.5

<sup>1</sup>Previous study titled: **Ultra High Surface Speed for Metal Removal, Artillery Shell**

Contract Report ARLCD-CR-81019



## DISCUSSION OF TEST RESULTS

### 1340 MATERIAL - M483 PROJECTILE BODIES - ROUGHING CUTS - 207 TO 286 BRINELL HARDNESS (16 to 29 RC)

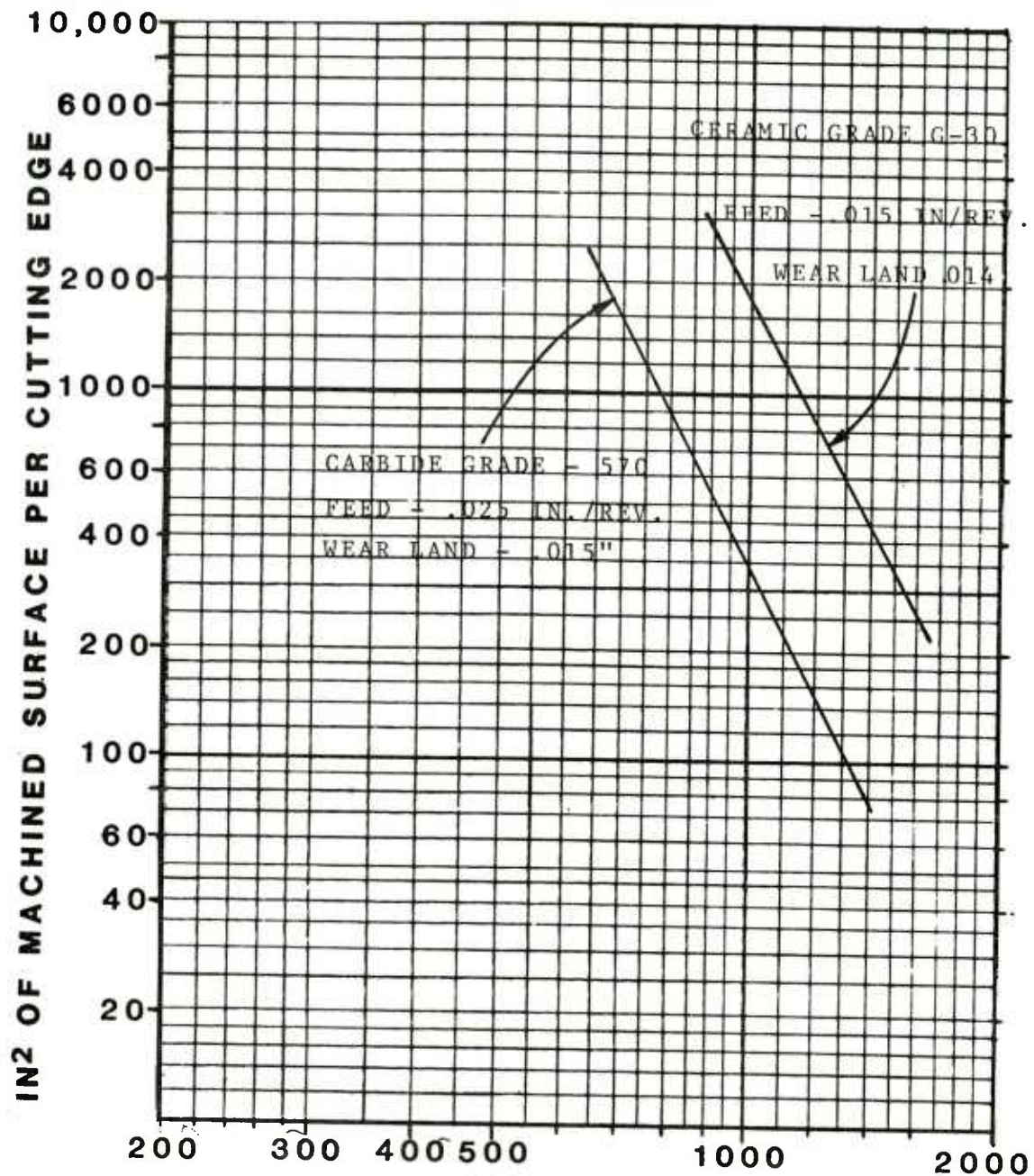
The ceramic-coated carbide, Carboloy Grade 570, was used starting at 700 surface feet per minute and at a feed rate of 0.025 inches per revolution (parameters derived from previous study). This surface speed was too great because the cutting edge had developed a wear-land of 0.017 inches after an area of only 1,000 square inches had been machined. The surface speed was then lowered to 630 feet per minute and two runs were made resulting in wear-lands in excess of 0.015 inches, with machined areas of 2,300 and 3,000 square inches. The values of 2,300 square inches and 0.015 inches of wear-land were used on the tool life-line curve, Figure 1, Page 9. The two wear-land versus square inches of machined surface curves are plotted on Figure 2, Page 10. The chips for above cut were continuous, approximately  $\frac{3}{8}$  inches in diameter and 2 to 6 inches in length.

The surface speed was then slowed down to 600 feet per minute and the results of this test are shown on Figure 3, Page 11. These conditions gave 58% less tool life than runs at 630 surface feet per minute. The reason for this apparent discrepancy is unknown.

Cold-pressed ceramic, G-30, was tried at 830 feet per minute and .022 inches per revolution feed for two tests. Initially, both tests were satisfactory, but after a wear-land of .008 to .010 developed, the inserts cracked or chipped, so the tests were stopped. The speed was increased to 870 feet per minute, and the feed lowered to .015 inches per revolution. The results of two runs, at these conditions, are shown on Figure 4, Page 12. A value of 3,100 square inches and 0.015 inches wear-land was taken from this chart for a value to be used in plotting the tool life-line curve. Figure 1, Page 9. The chips for these cuts were  $\frac{1}{2}$  inch in diameter with a single roll.

Hot-press ceramic, G-10, was used at 1,000 surface feet per minute and 0.015 inches per revolution feed and 970 feet per minute and 0.022 inches per revolution feed. Both conditions did not give reliable results, and testing was discontinued. The data sheets for all of the above tests can be found in Tables 3 to 25, Page 60 to 82.

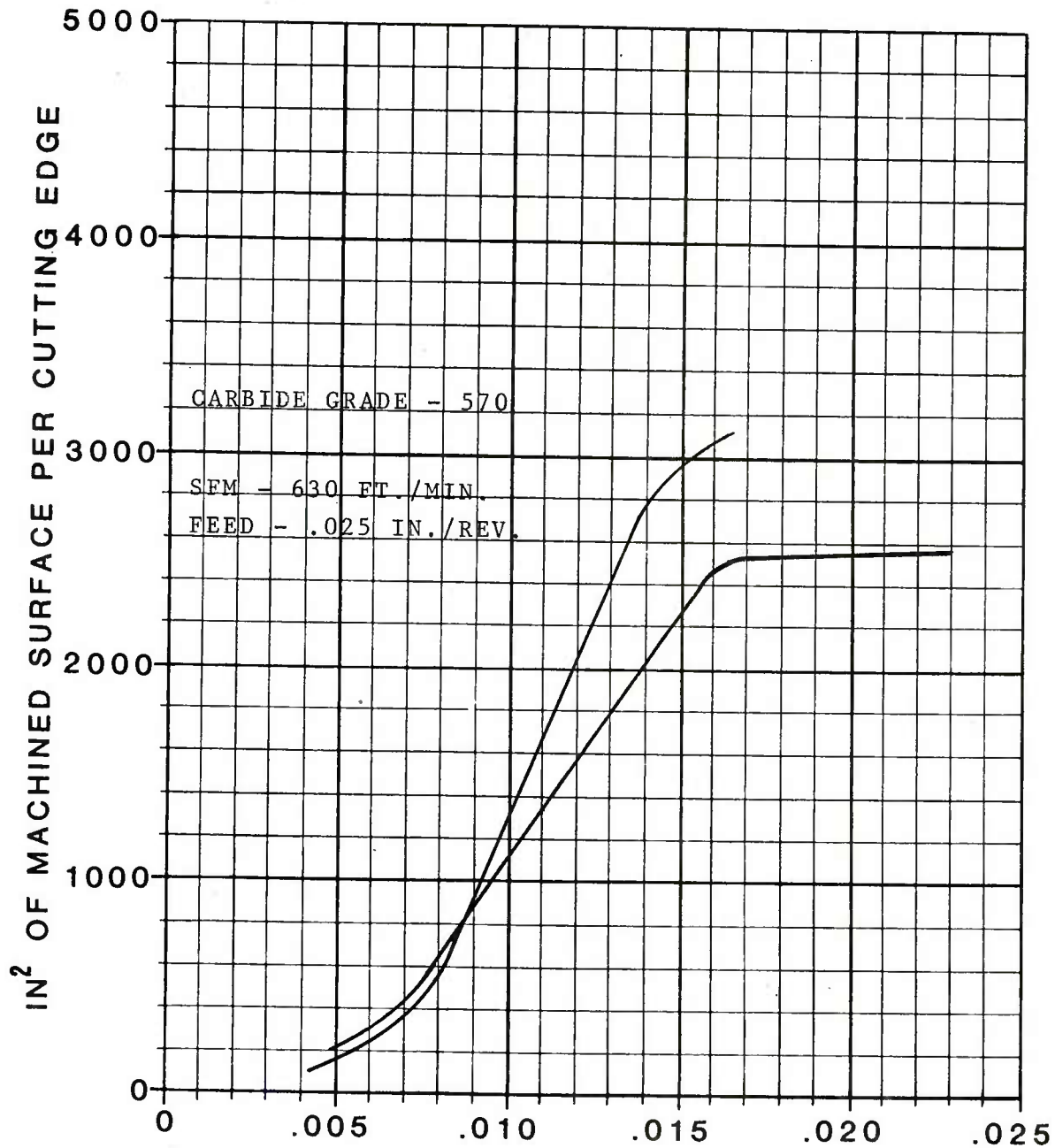




**FIGURE 1: CUTTING SPEED - FEET PER MINUTE**  
TOOL LIFE-LINES OF LISTED CUTTING MATERIALS ON 134C  
STEEL AT 207/286 BRINELL HARDNESS (16 TO 29 R<sub>c</sub>)

DEPTH OF CUT - .100 INCHES

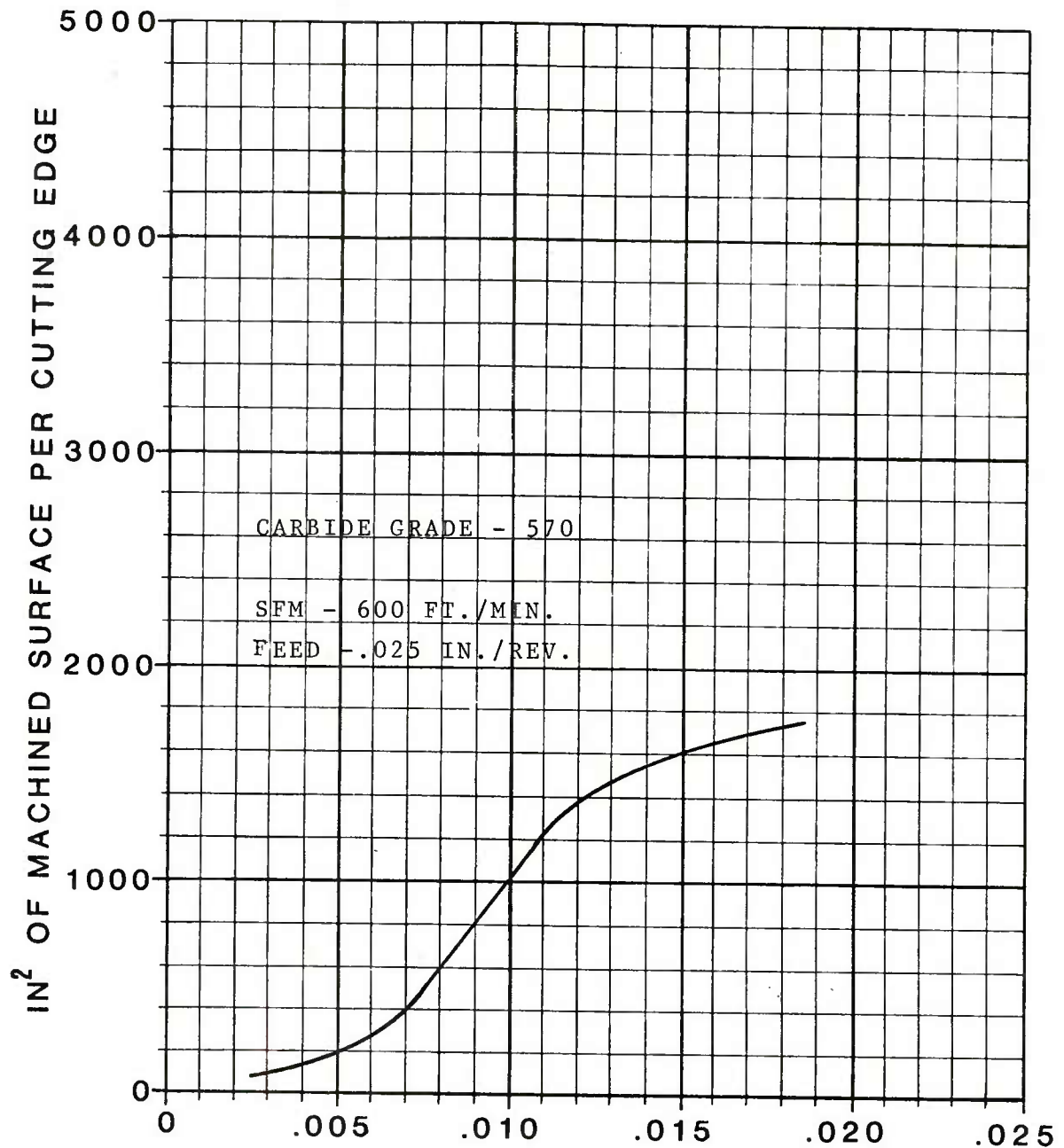
HOLDER (570) - CTANR-164 (0° LEAD ANGLE)  
INSERT (570) - TNMG-433E48  
HOLDER (G-30) - CCGNR-164 (0° LEAD ANGLE)  
INSERT (G-30) - CNG-454-820



**FIGURE 2: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

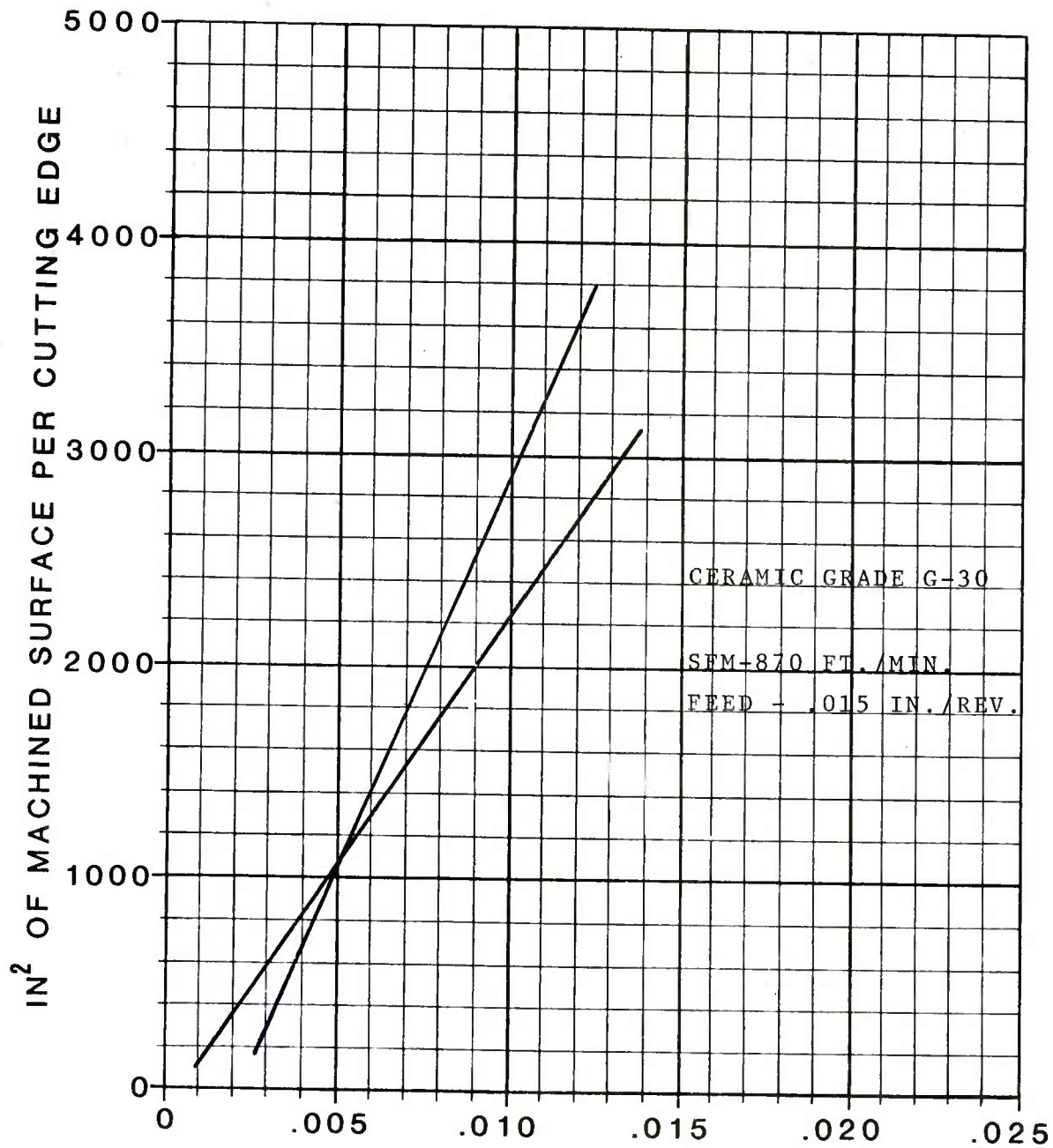
Projectile Material - 1340  
 Projectile Hardness Range - 207/255 BHN.  
 Depth of Cut (approx.) - .100 INCHES  
 Tool Holder - CTANR-164  
 Insert - TNMG-433-E48  
 For Curve Data see tables 5 to 8 - Pages 62 to 65



**FIGURE 3: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	1340
Projectile Hardness Range	-	228/269
Depth of Cut (approx.)	-	.100 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433-E48
For Curve Data see tables 9 & 10 -Pages 66 & 67		



**FIGURE 4: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material - 1340  
 Projectile Hardness Range - 217/286 BHN.  
 Depth of Cut (approx.) - .100 INCHES  
 Tool Holder - CCGNR-164  
 Insert - CNG-454-820  
 For Curve Data see tables 11 to 16 - Pages 68 to 73

**1340 MATERIAL - M483 PROJECTILE FORGINGS - FINISHING CUTS -  
302 TO 364 BRINELL HARDNESS (31/38 RC)**

From the previous study, the surface speed required to develop 2500 square inches of machined surface was determined to be 470 feet per minute at a 0.015 inches per revolution feed using Carboloy Grade 570. The tests were started using 480 surface speed, with a 0.015 inches per revolution feed. The cutting edge developed 0.0225 inches of wear-land while turning 2852 square inches of machined surface. When plotted, these values showed an unusual wear pattern, so the cutting speed was lowered to 440 feet per minute. When the results of these tests were plotted, this curve again showed unusual wear. From this chart, Figure 6, Page 16, values of 3100 square inches of machined area, at a surface speed of 440 feet per minute and a wear-land of 0.018 inches, and 2500 square inches, at 480 surface feet per minute and a wear-land of 0.018 inches, were used for plotting the life-line of this material on Figure 5, Page 15. The other points for this life-line were taken from the previous tests.

The chip condition for the above tests were a continuous  $\frac{1}{2}$ " diameter roll from 3" to 12" in length. As the tool wore, the chip became continuous.

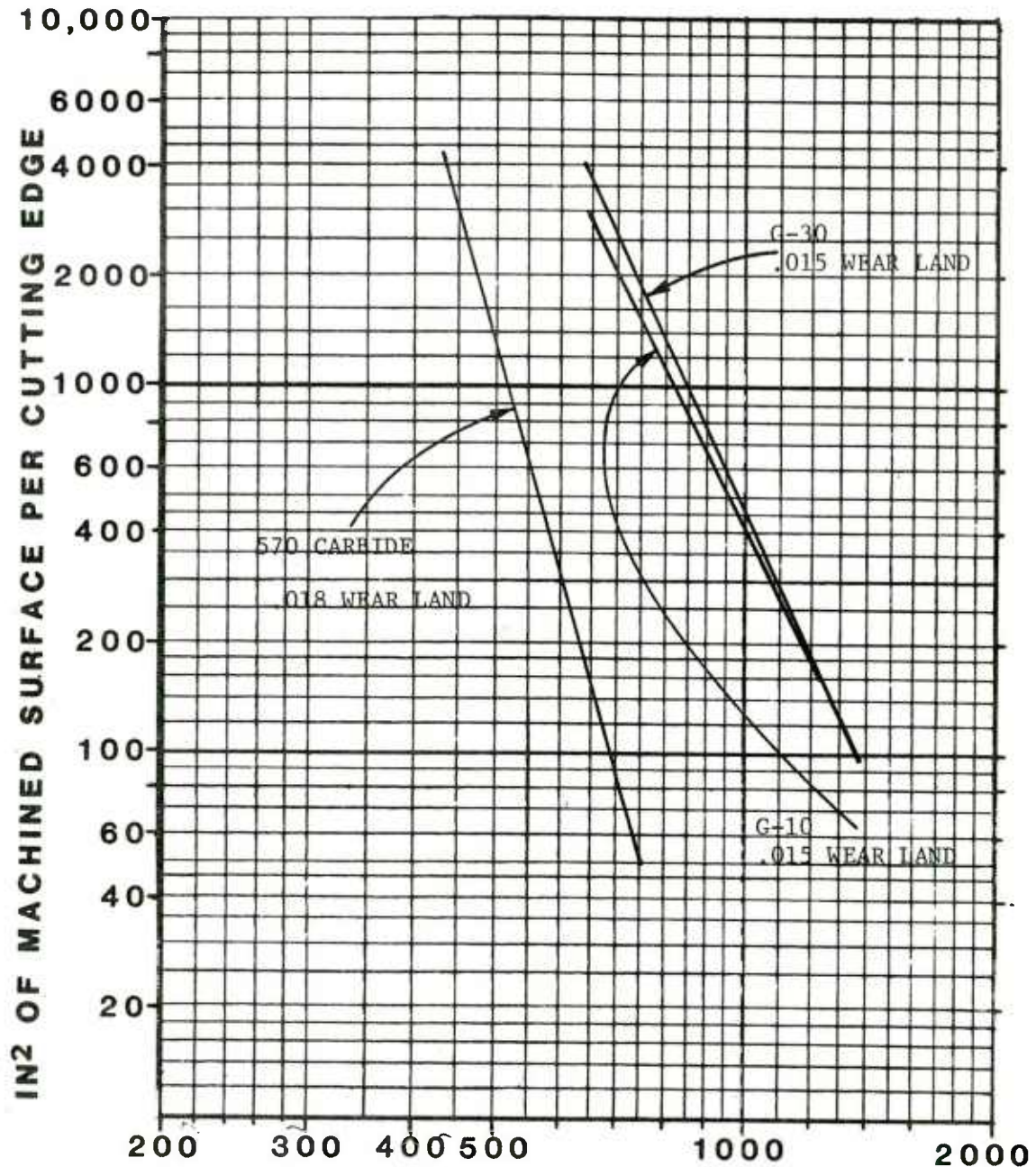
Ceramic Grade G-30 was tested at 660 surface feet per minute at a 0.015" per revolution feed, derived from the previous study. For a second test, the surface speed was increased to 725 feet per minute, at the same feed rate. The results of these tests are shown on Figure 7, Page 17. Values of 3000 and 2700 square inches of machined surface for 660 and 725 surface feet per minute respectively were used in plotting the life-line of this material on Figure 5, Page 15. The other values were taken from the previous study. The chip conditions for the above tests were the same for both speeds; approximately  $\frac{1}{4}$ " in diameter, 8" to 12" in length.

Ceramic Grade G-10 was tested at 660 surface feet per minute with .015" per revolution feed. Two tests were made, at above conditions, using different "K" lands, which gave equal tool-life results. The results of these tests are shown on Figure 8, Page 18. The values of 2600 square inches of machined area, and 660 surface feet per minute, with data from the previous tests, were used in plotting the life-lines for this tool material on Figure 5, Page 15. The chip condition for this tool material, G-10, was the same as that of G-30. The data for all



the above tests is shown in Table 26 to Table 40, Page 85 to 99.

When conducting the tests for this material, as the tool wore and the radial load increased, the turned surface showed "banding". This only occurred when using the ceramic inserts. Two projectile bodies were machined on a TNC Shaft Machine with the same cutting conditions, tool holder, and inserts, but no "banding" occurred. The slide system of the machine was inspected and re-set after which, test results showed no banding. From this experience, a stiff machine with no "looseness" is imperative when machining these projectiles.



**FIGURE 5: CUTTING SPEED - FEET PER MINUTE**

TCOL LIFE-LINES OF LISTED CUTTING MATERIALS ON 1340 STEEL  
AT 302/364 BRINELL HARDNESS (32 TO 38 R<sub>C</sub>)

FEED - .015 INCHES PER REVOLUTION

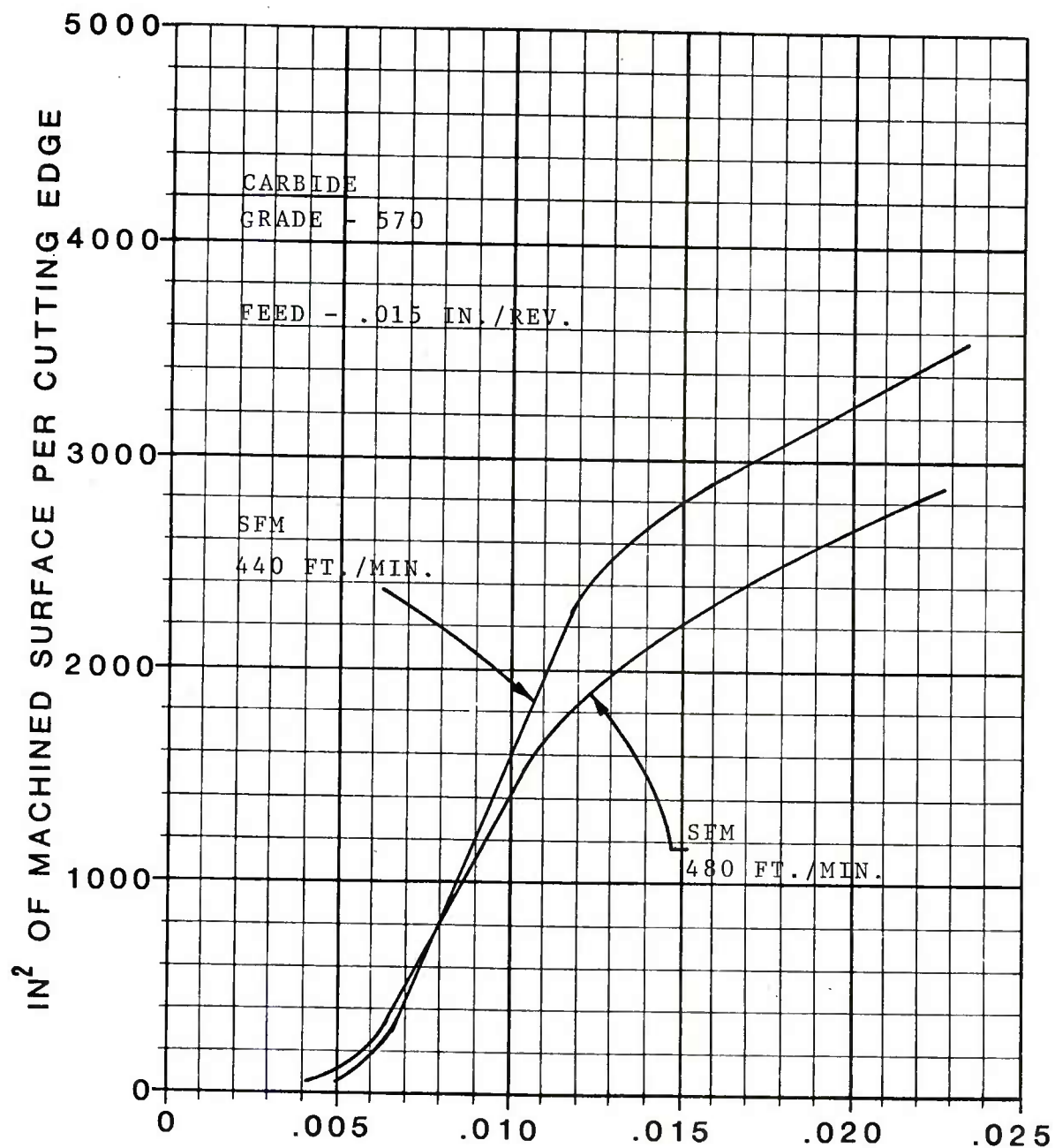
DEPTH OF CUT - .050 INCHES

HCLDER (570) - CTANR-164 (0° LEAD ANGLE)

INSERT (570) - TNMG-433-E48

HCLDER (G-10 & G-30) - CCGNR-164 (0° LEAD ANGLE)

INSERT (G-10 & G-30) - CNG-454-820

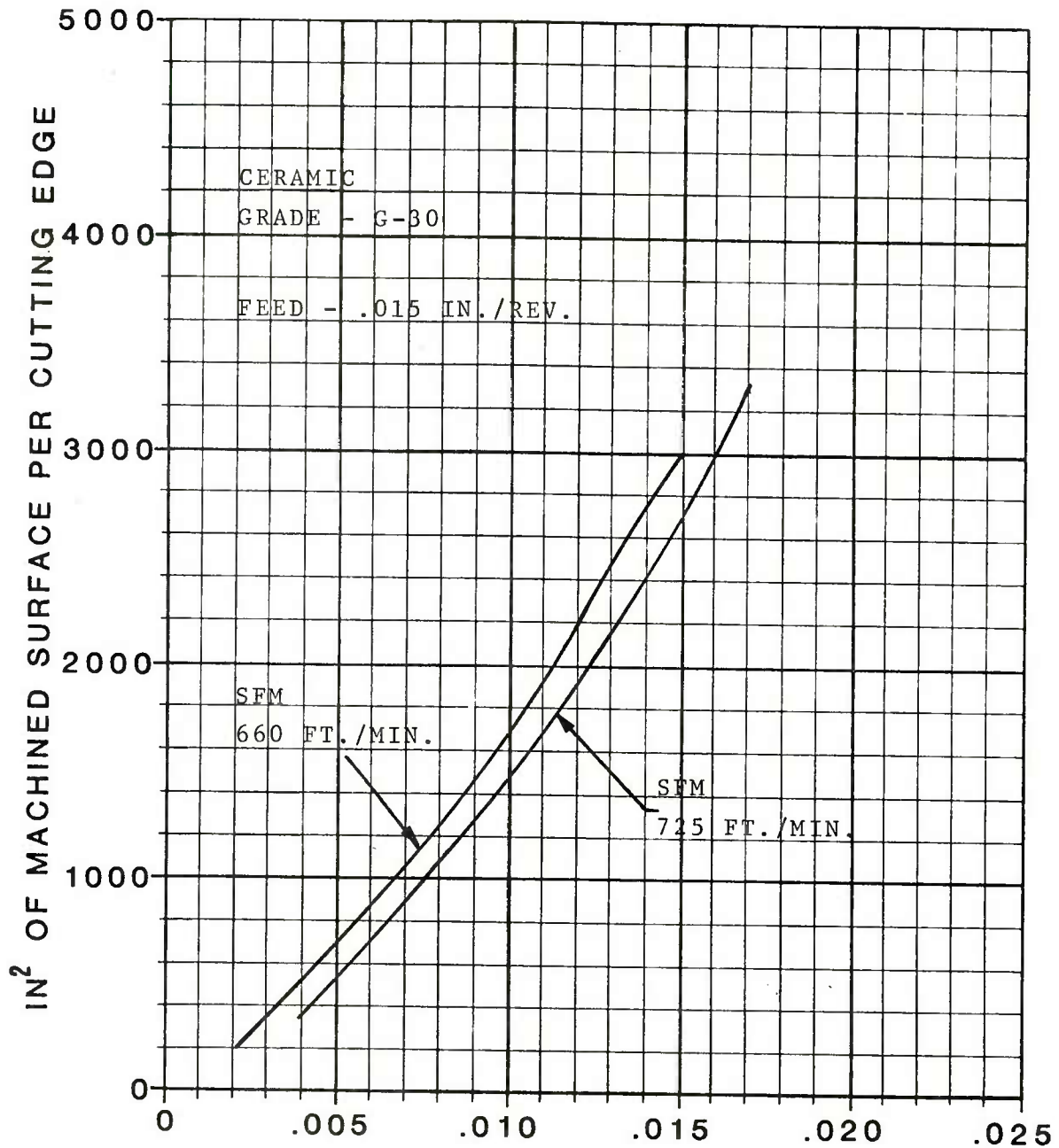


**FIGURE 6: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	1340
Projectile Hardness Range	-	302/364 BHN.
Depth of Cut (approx.)	-	.050 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433E48
For Curve Data see tables 28 to 31 - Pages 87 to 90		

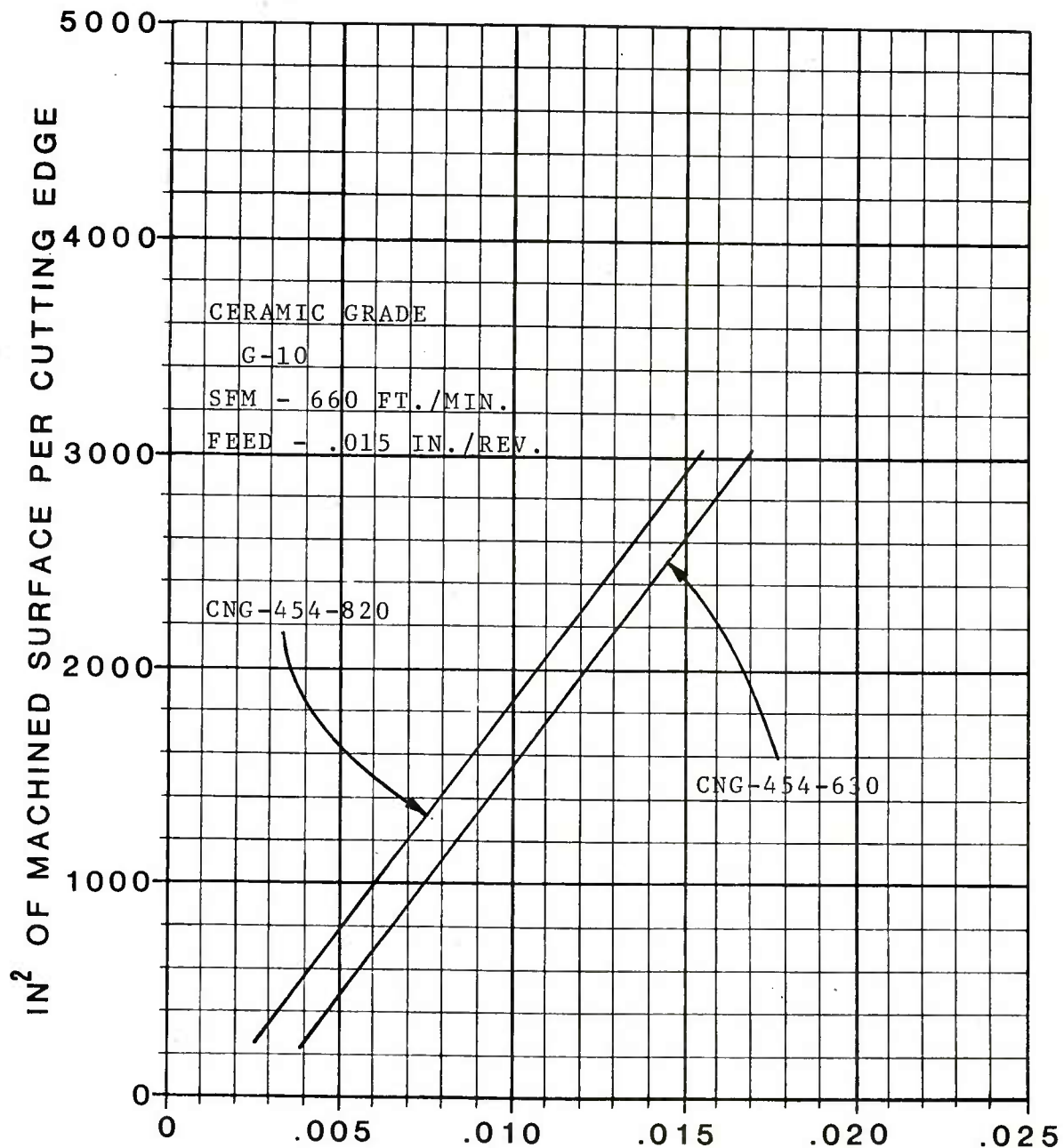




**FIGURE 7: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	1340
Projectile Hardness Range	-	321/364 BHN.
Depth of Cut (approx.)	-	.050 INCHES
Tool Holder	-	CCGNR-164
Insert	-	CNG-454-630
For Curve Data see tables 32 to 35 - Pages 91 to 94		



**FIGURE 8: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 1340
Projectile Hardness Range	- 302/340 BHN.
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CCGNR-164
Insert	- SEE GRAPH
For Curve Data see tables 36 to 39 - Pages 95 to 98	

#### **4140 MATERIAL - M509 PROJECTILE FORGINGS - ROUGHING CUTS - 170 TO 217 BRINELL HARDNESS (8/18 RC)**

From the previous tests conducted on solid 4140 bars, results indicated that for 570 carbide, the material should be machined at 360 surface feet per minute with a feed rate of 0.033 inches per revolution. The hardness of the projectile bodies ranged from 170 to 217 Brinell Hardness while the test billet in the previous study was 302/321 Brinell Hardness. Initially, cuts were taken at 360 feet per minute at .033 inches per revolution feed, and 5,000 square inches of machined area was generated while developing a wear-land of 0.020 inches. This result was as expected.

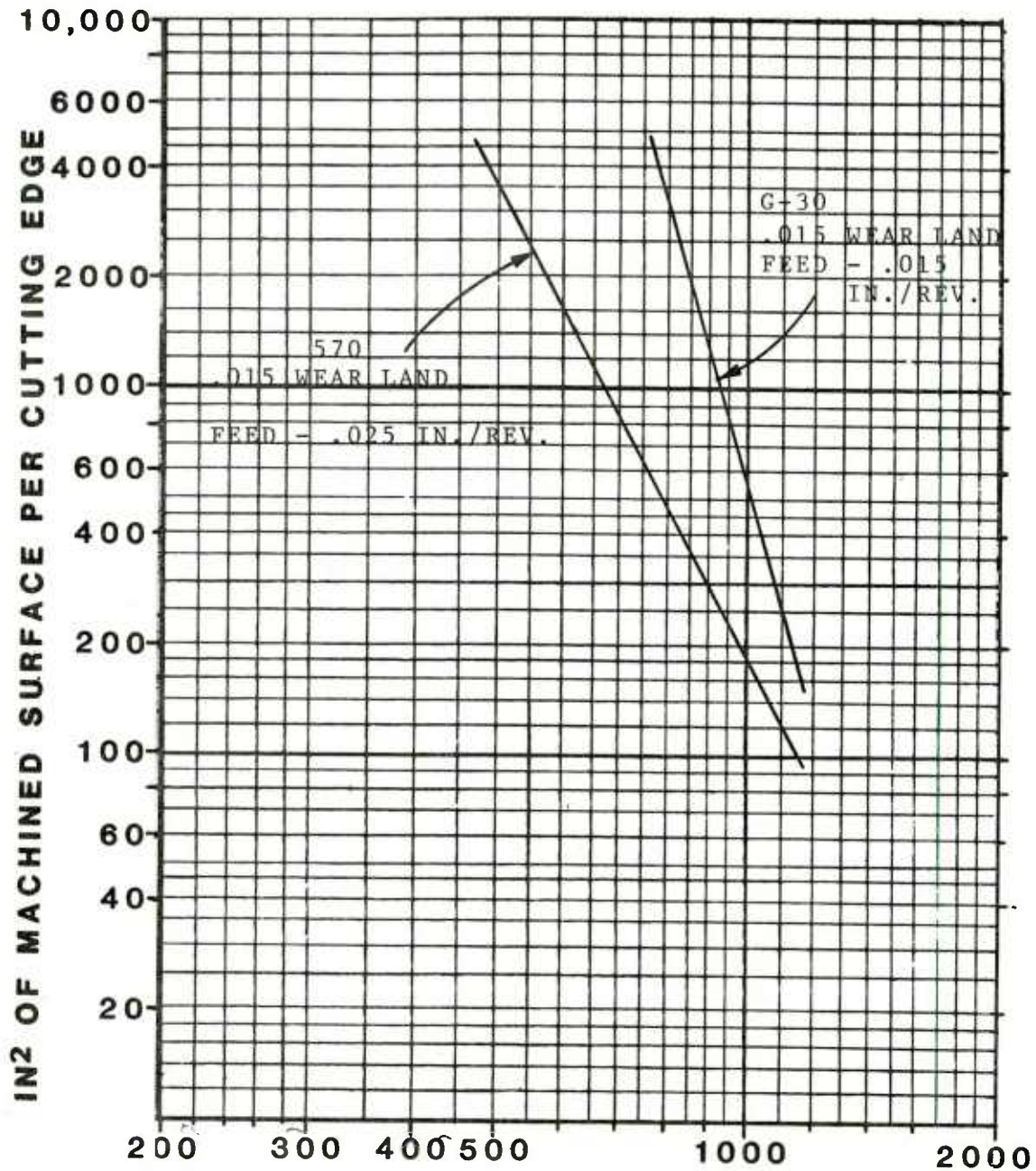
The surface speed was increased to 400 feet per minute, using 0.033 inches per revolution feed-rate, and 3,000 square inches of area was machined before 0.014 inches of wear-land developed. The results of the tests showed that a smaller wear-land of (0.014 vs 0.0165) was attained, than when 3,000 square inches of area was machined at 360 feet per minute. The surface speed was increased again, this time to 500 feet per minute using the same feed-rate. This, however, resulted in tool breakage. The life-line was then developed for the material using a 0.033 feed-rate which indicated a cutting speed of 600 feet per minute should be used, but when this was tried, tool breakage again occurred.

A life-line for 0.025 inches per revolution feed was made, which indicated a cutting speed of 500 feet per minute should develop 2,500 square inches of machined area when the cutting edge is worn to a 0.015 inches wear-land. Tests were conducted which gave 3,000 square inches of machined area for 0.0125 and 0.014 inches of wear-land. The cutting edges in both tests were run to 4,000 square inches of machined area, with wear as the determining factor. Breakage did not occur and there was no chipping of the insert which might precede breakage. The results of these tests are shown on Figure 10, Page 22, which indicate that for a wear-land of 0.015 inches, 3,500 square inches of surface can be machined. This point, along with square inch values at 800 and 1,000 surface feet per minute, was used to plot the life-line of this material on Figure 9, Page 21. The chips curled to approximately a ¼" diameter and rolled to 2 inches in length.

Hot-press ceramic inserts, G-10, were tried on this material at various speeds, and chipping of the insert occurred. This normally results in unpredictable failures, so these tests were stopped. It was concluded that the cutting material would not operate under these conditions with any degree of reliability.

Cold-press ceramic, G-30, was tried on this material at various speeds and at 0.015 inches per revolution feed with the  $0^\circ$  lead angle tool, with negative results. Chipping of the insert occurred at the "edge of work" area and on the nose radius.

The holder was then changed to one with a  $45^\circ$  lead angle using a square insert, and two tests were made where the insert generated 0.025 inches of wear-land. During these tests, some slight chipping took place in the wear-land. The conditions for these tests were 850 surface feet per minute at 0.015 inches per revolution feed. They are plotted on Figure 12, Page 24. From this chart a value of 2,000 square inches of machined area, at a wear-land of 0.015 inches, and values of machined area at 1,000 and 1,100 surface footage were used to plot the life-line of this material on Figure 9, Page 21. The chips for these cuts were single rolls approximately  $\frac{5}{8}$ " in diameter, the data sheets for all the above tests can be found in Tables 41 to 66. Page 103 to 128.



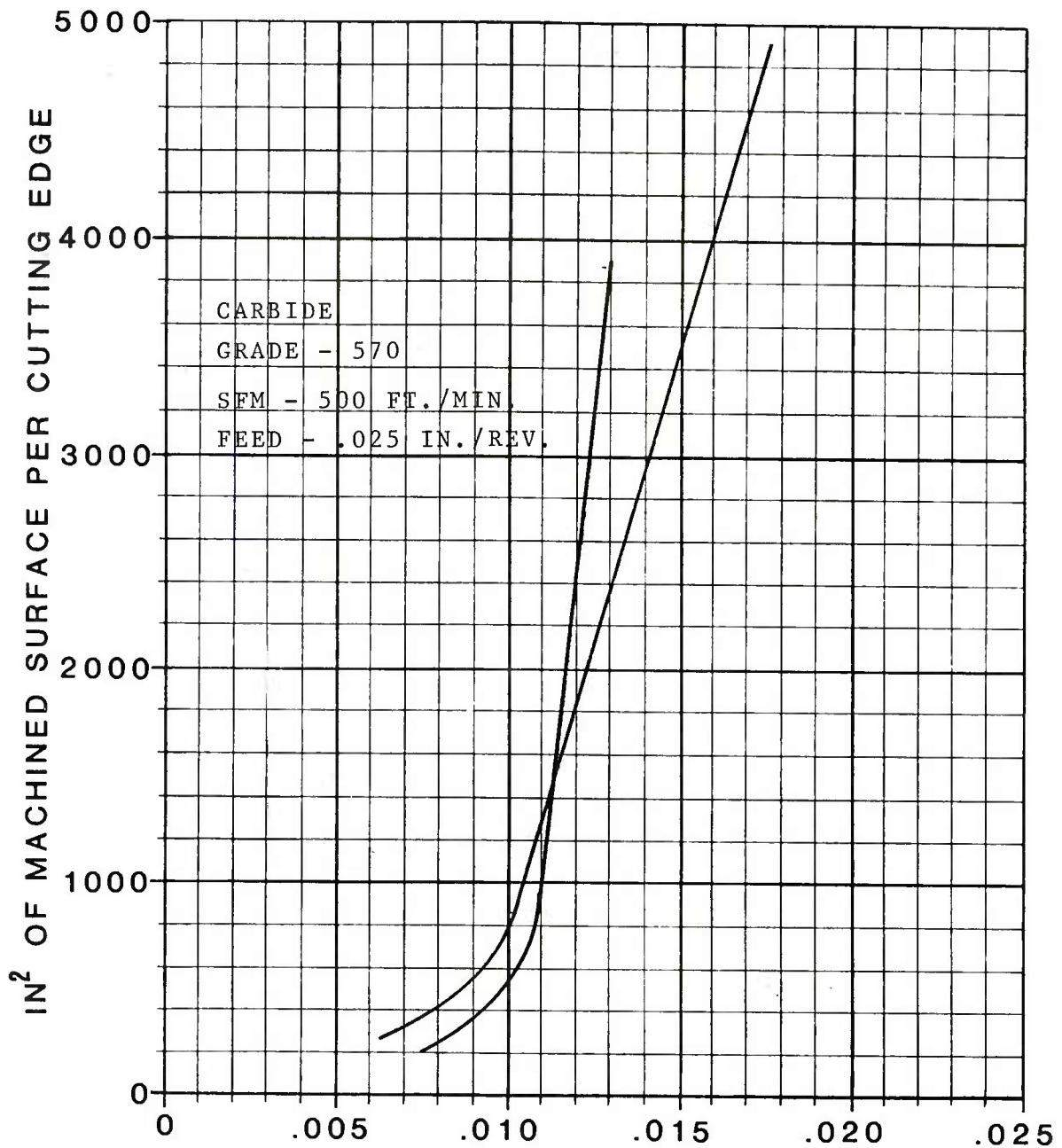
**FIGURE 9: CUTTING SPEED - FEET PER MINUTE**

TOOL LIFE-LINES OF LISTED CUTTING MATERIALS ON 4140  
STEEL AT 170/217 BRINELL HARDNESS (8 TO 18  $R_c$ )

DEPTH OF CUT - .100 INCHES

FOLDER (570) - CTANR-164 ( $0^\circ$  LEAD ANGLE)  
 INSERT (570) - TNMG-433E48  
 FOLDER (G-30) - CSDNN-165 ( $45^\circ$  LEAD ANGLE)  
 INSERT (G-30) - SNG-554-1230

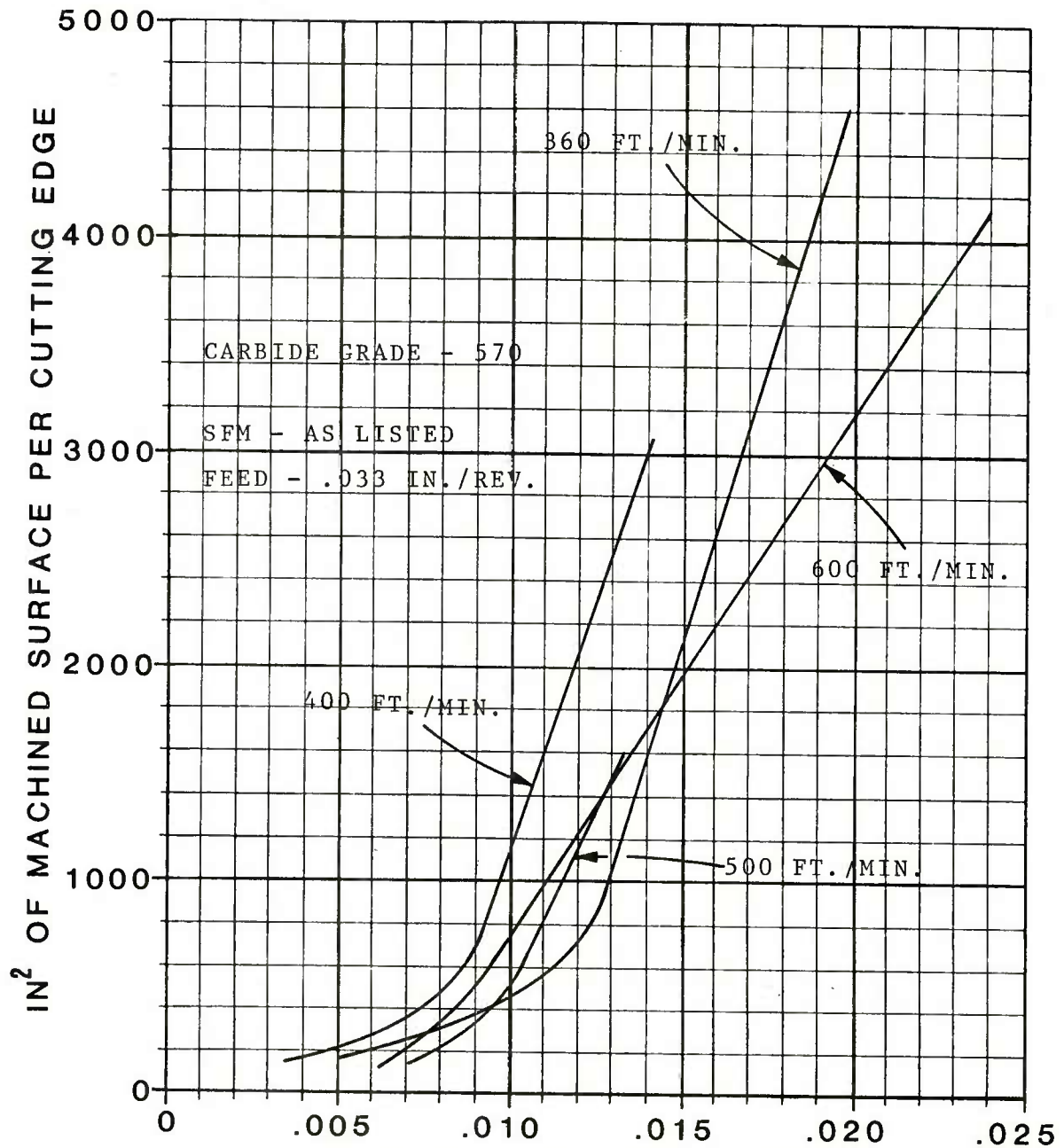




**FIGURE 10: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 4140
Projectile Hardness Range	- 179/217 BHN. (10/18 R <sub>c</sub> )
Depth of Cut (approx.)	- .100
Tool Holder	- CTANR-164
Insert	- TNMG-433-E48
For Curve Data see tables 52 to 56 - Pages 114 to 118	

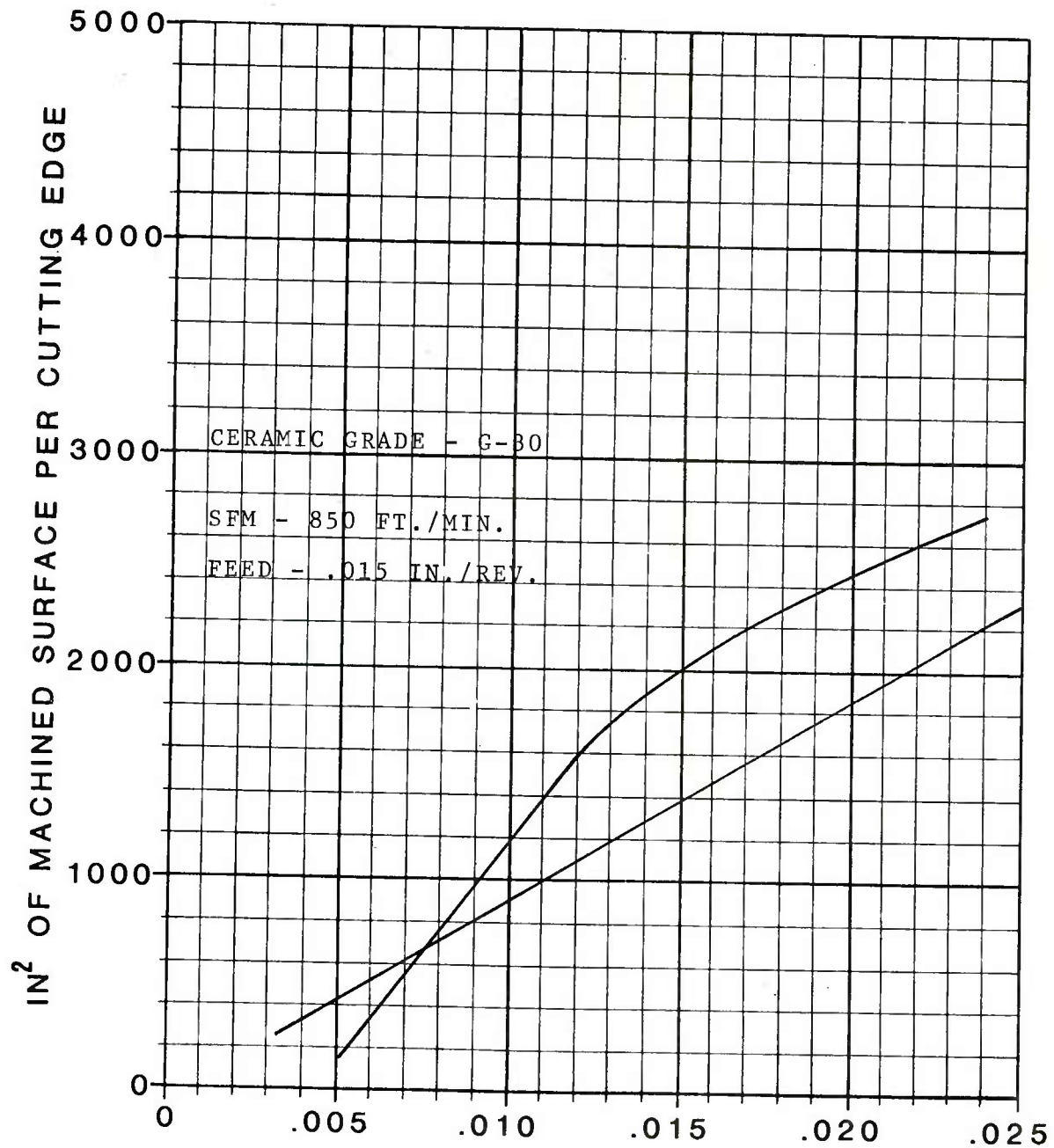


**FIGURE 11: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	4140
Projectile Hardness Range	-	170/207 BHN. (8/16 R <sub>c</sub> )
Depth of Cut (approx.)	-	.100 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433 E48

For Curve Data see tables 42 to 51 - Pages 104 to 113



**FIGURE 12: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	4140
Projectile Hardness Range	-	170/207 BHN. (8/16 R <sub>c</sub> )
Depth of Cut (approx.)	-	.100 INCHES
Tool Holder	-	CSDNN-165 (45° LEAD ANGLE)
Insert	-	SNG-554-1230
For Curve Data see tables 61 to 63 - Pages 123 to 125		

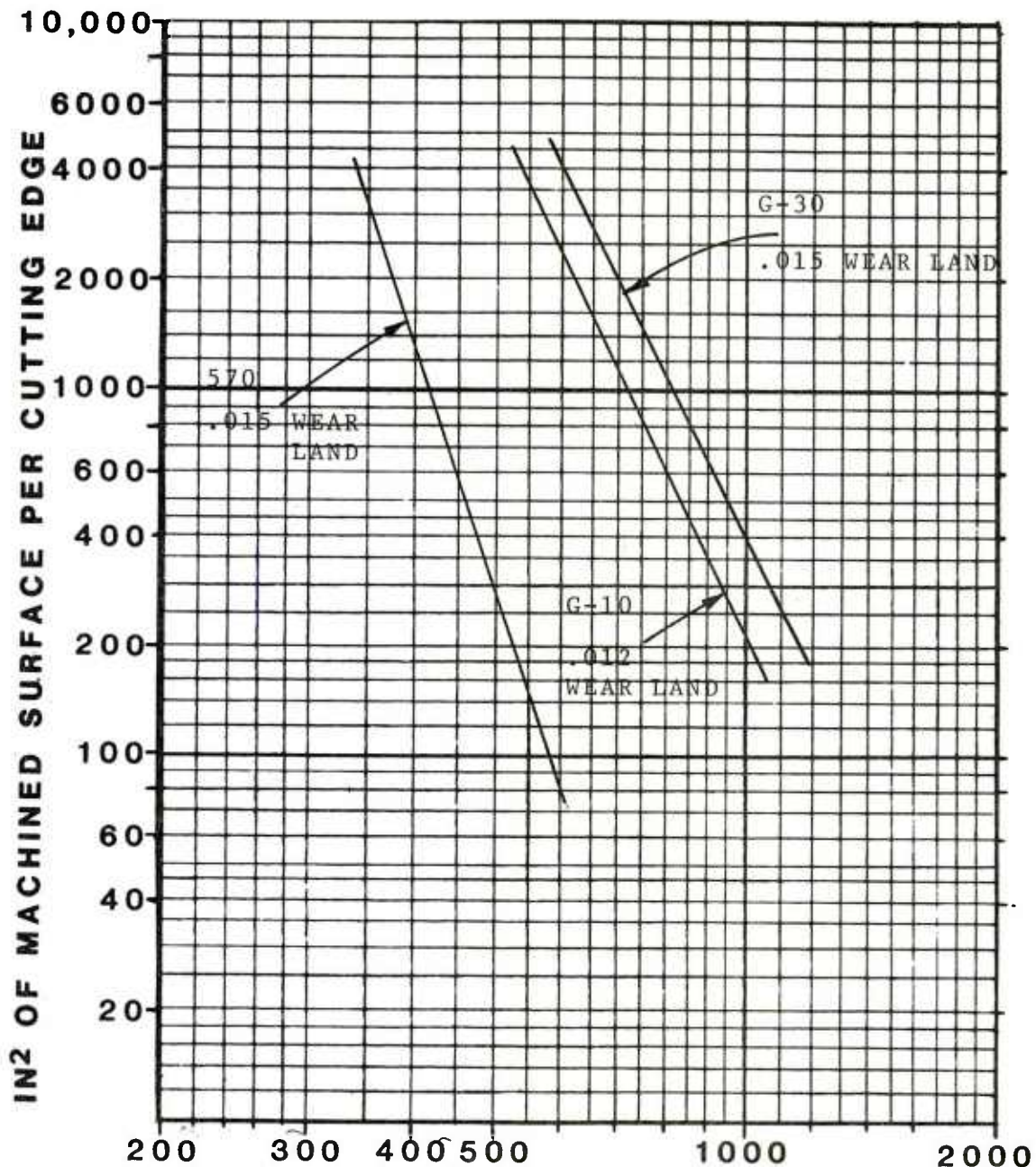


**4140 MATERIAL - M509 PROJECTILE FORGINGS - FINISHING CUTS -  
364 TO 418 BRINELL HARDNESS (38/43 RC)**

The ceramic-coated carbide, Carboloy 570, was tested at 400 surface feet per minute at a feed rate of 0.015 inches per revolution, but the tool life was too low. The surface speed was lowered to 340 feet per minute with the same feed rate, which resulted in a machined surface of 3500 square inches. The cutting speed was then increased to 370 feet per minute and the tests completed. The results of these tests are shown on Figure 14, Page 27. This shows how a small change in cutting speed can cause a large change in tool life. The results of the above tests, with another test at 550 surface speed, were used to plot the life-line of this material in Figure 13, Page 26. The chip condition for the above tests was a continuous roll approximately  $\frac{1}{2}$ " in diameter. There was no noticeable change in chip formation among the three cutting speeds.

Ceramic Grade G-30 was tested at 600 surface feet per minute, with a feed rate of 0.015 inches per revolution. This test did not go to 0.015 inches wear-land, but did serve as a guide in determining the proper cutting speed. The speed was increased to 650 surface feet per minute and run to a wear-land in excess of 0.015 inches. The results of these two tests are plotted on Figure 15, Page 28. Another test was made at 1,000 surface feet per minute and the values of these tests were used to plot the life-line in Figure 13, Page 26. The chip conditions of the two tests resulted in chip  $\frac{1}{4}$ " in diameter, 8" to 10" in length.

Ceramic Grade G-10 was tested at 700 surface feet per minute for three successive tests. The first two tests were made using coolant and showed a significant difference in tool life. The third test was made with no coolant. The variations in test results are shown on Figure 16, Page 29. Another test of 850 surface feet per minute was done and the three points were used in plotting the life-line for this material on Figure 13, Page 26. The chips were continuous, with a  $\frac{1}{2}$ " diameter and 2" to 10" in length. The data for all the above tests can be seen in Table 67 to Table 84, Page 131 to Page 148.

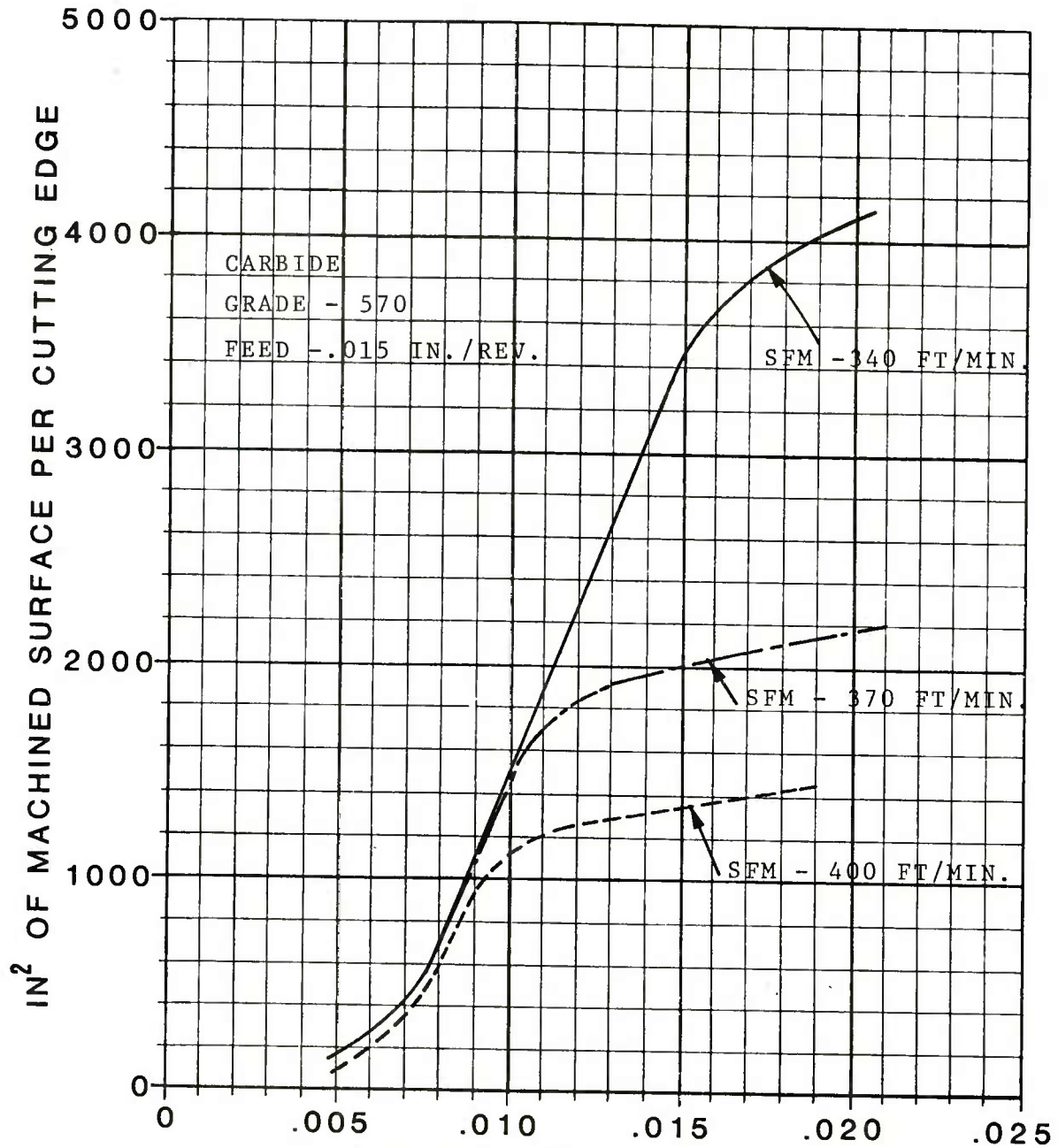


**FIGURE 13: CUTTING SPEED - FEET PER MINUTE**

TOOL LIFE-LINES OF LISTED CUTTING MATERIALS ON 4140  
STEEL AT 364/418 BRINELL HARDNESS (38 TO 43 R<sub>C</sub>)

FEED - .015 INCHES PER REVOLUTION  
DEPTH OF CUT - .050 INCHES

HOLDER (570) - CTANR-164 (0° LEAD ANGLE)  
INSERT (570) - TNMG-433  
HOLDER (G-10 & G-30) - CCGNR-164 (0° LEAD ANGLE)  
INSERT (G-10 & G-30) - CNG-454

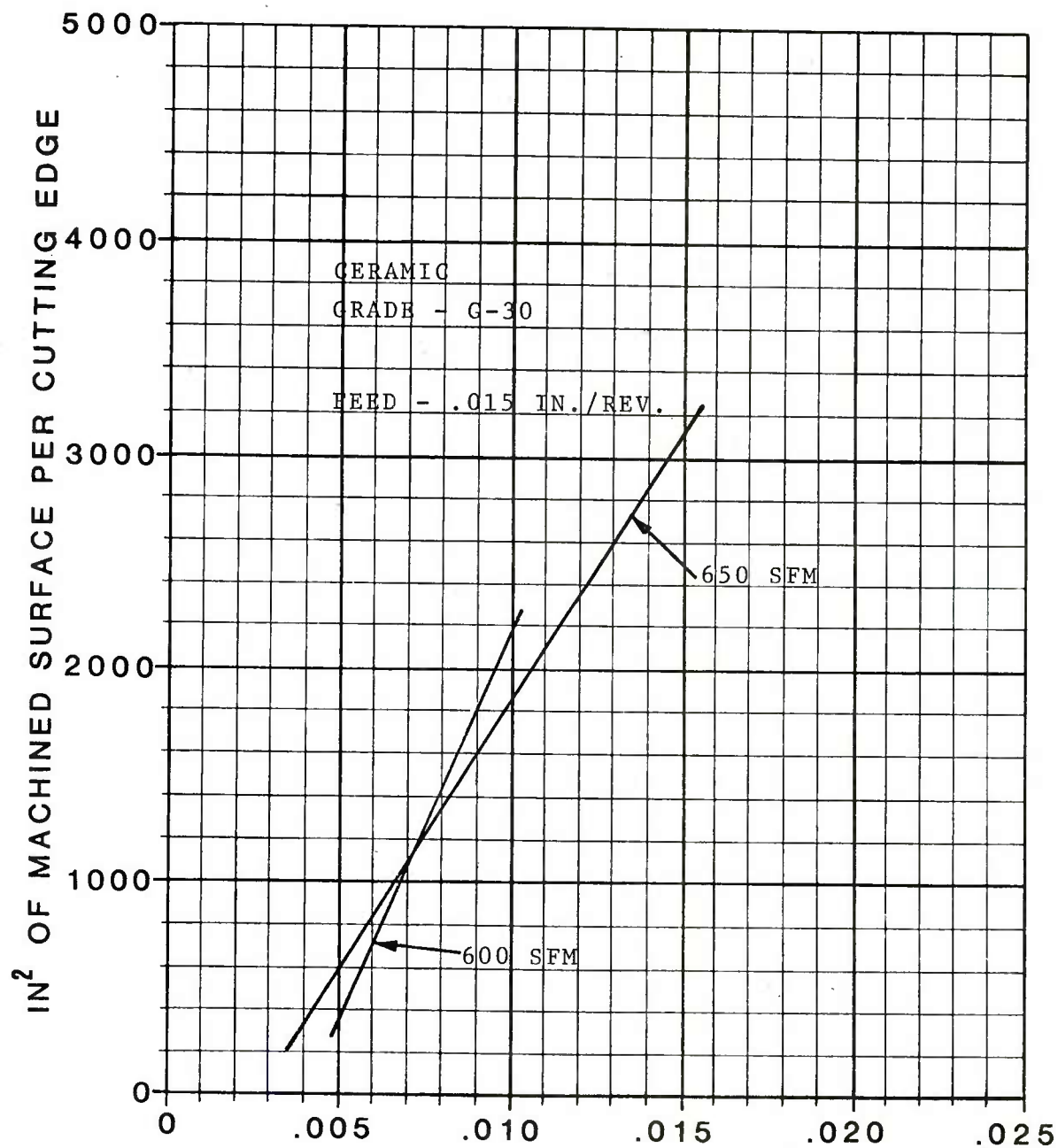


**FIGURE 14: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 4140
Projectile Hardness Range	- 364/418 BHN. (38/43 R <sub>c</sub> )
Depth of Cut (approx.)	- .050
Tool Holder	- CTANR-164 (0° LEAD ANGLE)
Insert	- TNMG-433E48

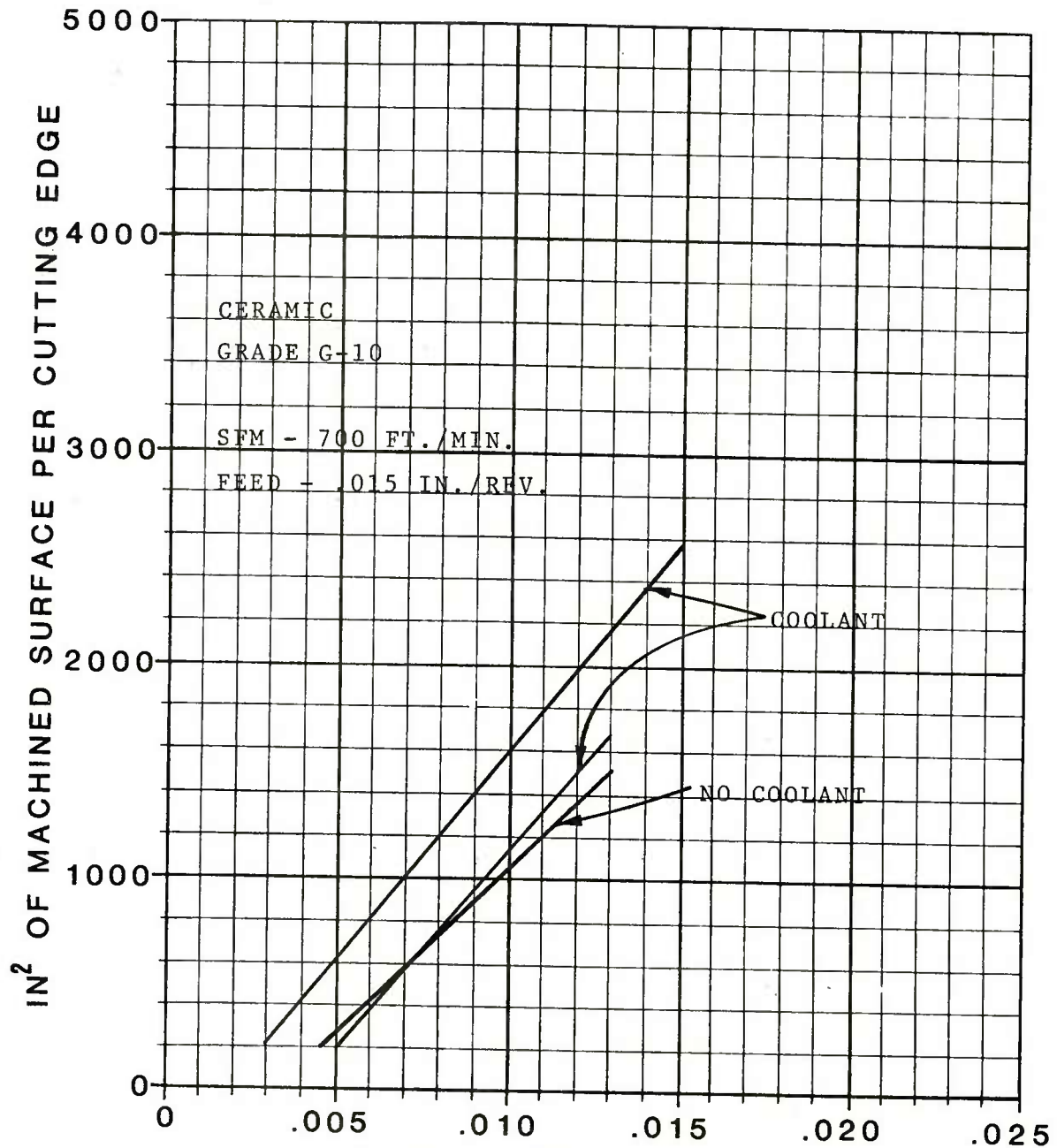
For Curve Data see tables 68 to 72 - Pages 132 to 136.



**FIGURE 15: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 4140
Projectile Hardness Range	- 364/418 BHN. (38/43 R <sub>c</sub> )
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CCGNR-164
Insert	- CNG-454-820
For Curve Data see tables 73 to 76 - Pages 137 to 140	



**FIGURE 16: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 4140
Projectile Hardness Range	- 364/418 BHN. (38/43 R <sub>c</sub> )
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CCGNR-164
Insert	- CNG-454-820
For Curve Data see tables 79 to 82 - Pages 143 to 146	



#### **4340 MATERIAL - M549 MOTOR BODIES - ROUGHING CUTS - 217 TO 321 BRINELL HARDNESS (18 TO 34 RC)**

Ceramic-coated carbide, Carboloy Grade 570, was tested at 400 surface feet per minute with a feed rate of 0.033 inches per revolution. Only 1,600 square inches of area was machined before breakage occurred. The feed was lowered to 0.025 inches per revolution and various surface speeds tried, but all tests ended with tool breakage. The feed rate was again lowered to 0.022 inches per revolution, with a surface speed of 400 feet per minute, and two tests were run. The results are plotted on Figure 18, Page 33. The chart shows that 3,400 square inches of area can be machined while generating 0.018 inches of wear-land. This value along with the area machined at 800 and 1,000 surface footage, is used to plot the life-line of this material on Figure 17, Page 32. The chips were continuous rolls at 2 to 4 inches in length, and approximately  $\frac{1}{4}$ " in diameter.

When machining the parts for the above tests, it was noted that there were some large variations in tool loads as the tool progressed through a cut. A cross-section of a part that had been turned and the load charts for a cut are shown in Figure 21, Page 36. Some of the variations in tool loads are due to out-of-roundness, either in the part or in the chucking of the part. The other variations in tool loads come from the differences in the material from piece to piece.

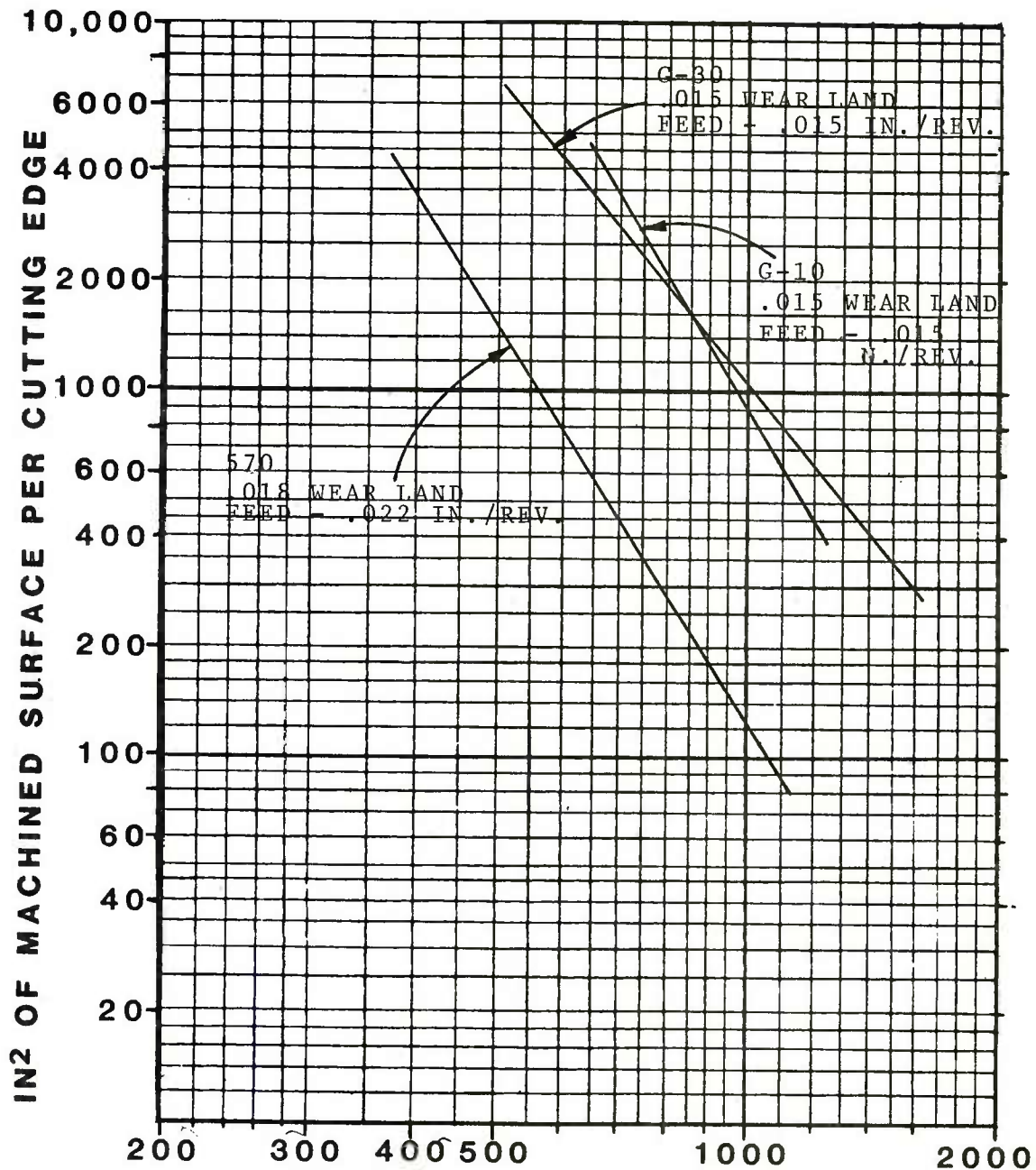
Cold-press ceramic, G-30, was tested at 700 feet per minute using a feed rate of 0.015 inches per revolution. Two tests were made using these conditions and the results plotted on Figure 19, Page 34. From this chart, a value of 2,800 square inches of machine surface and .015 inches wear-land, along with the value of machined area at 1,000 and 1,400 surface speed, was used to plot the life-line curve on Figure 17, Page 32.

The chips varied from  $\frac{1}{2}$ " to  $\frac{3}{4}$ " in diameter, and were 2" to 8" in length. As the tool wore, the chip diameter became smaller. The feed rate was increased to 0.022" per revolution, but cracks and chips in the insert indicated that the feed rate was too high for this material.

Hot-press ceramic, G-10, was tried at 0.015 inches per revolution feed at 800 feet per minute and the results plotted on Figure 20, Page 35. Other values of machined area were obtained at 1,000 feet per minute and these values used to plot the life-line on Figure 17, Page

32. Due to the poor results obtained at 0.015" per revolution feed, 0.022" feed rate was not tried. The data sheets for all the above tests are found in Tables 85 to 122, Page 152 to 189.





**FIGURE 17: CUTTING SPEED - FEET PER MINUTE**

TCOL LIFE-LINES OF LISTED CUTTING MATERIALS ON 4340  
STEEL AT 228/286 BRINELL HARDNESS (21 TO 29 R<sub>c</sub>)

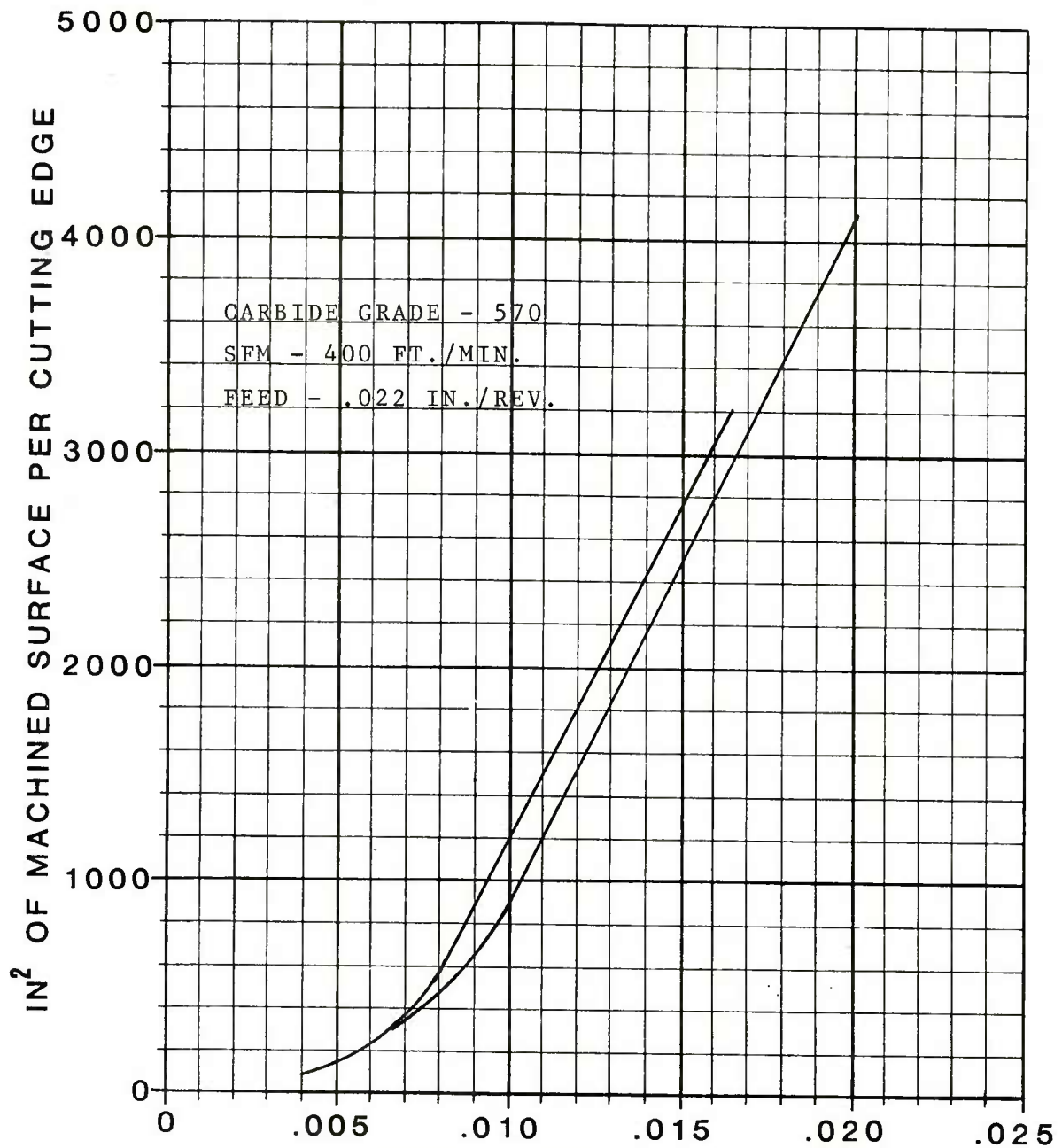
DEPTH OF CUT - .100 INCHES

HCLDER (570) - CTANR-164 (0° LEAD ANGLE)

INSERT (570) - TNMG-433E48

HCLDER (G-10 & G-30) - CCGNR-164 (0° LEAD ANGLE)

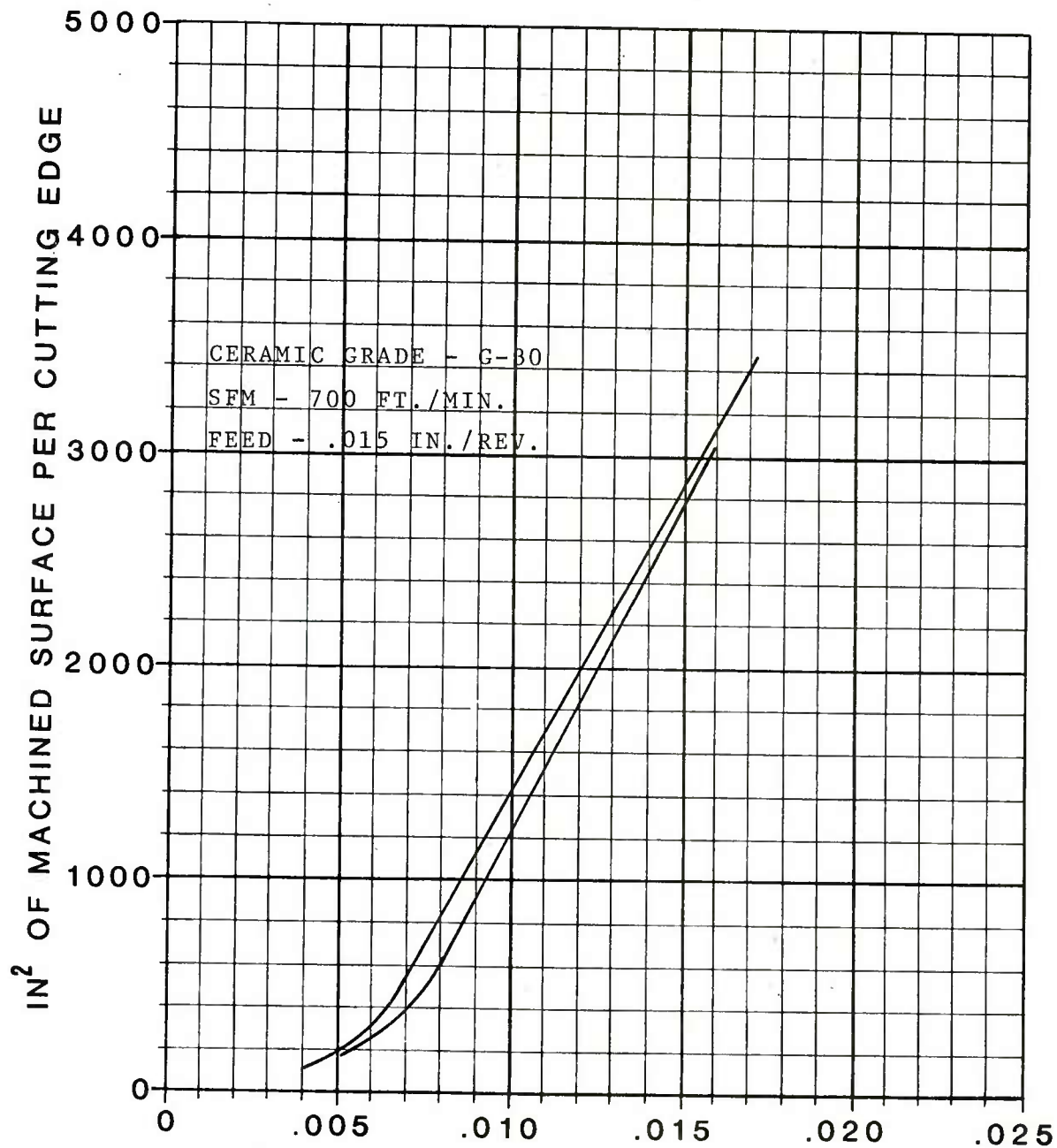
INSERT (G-10 & G-30) - CNG-454-820



**FIGURE 18: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

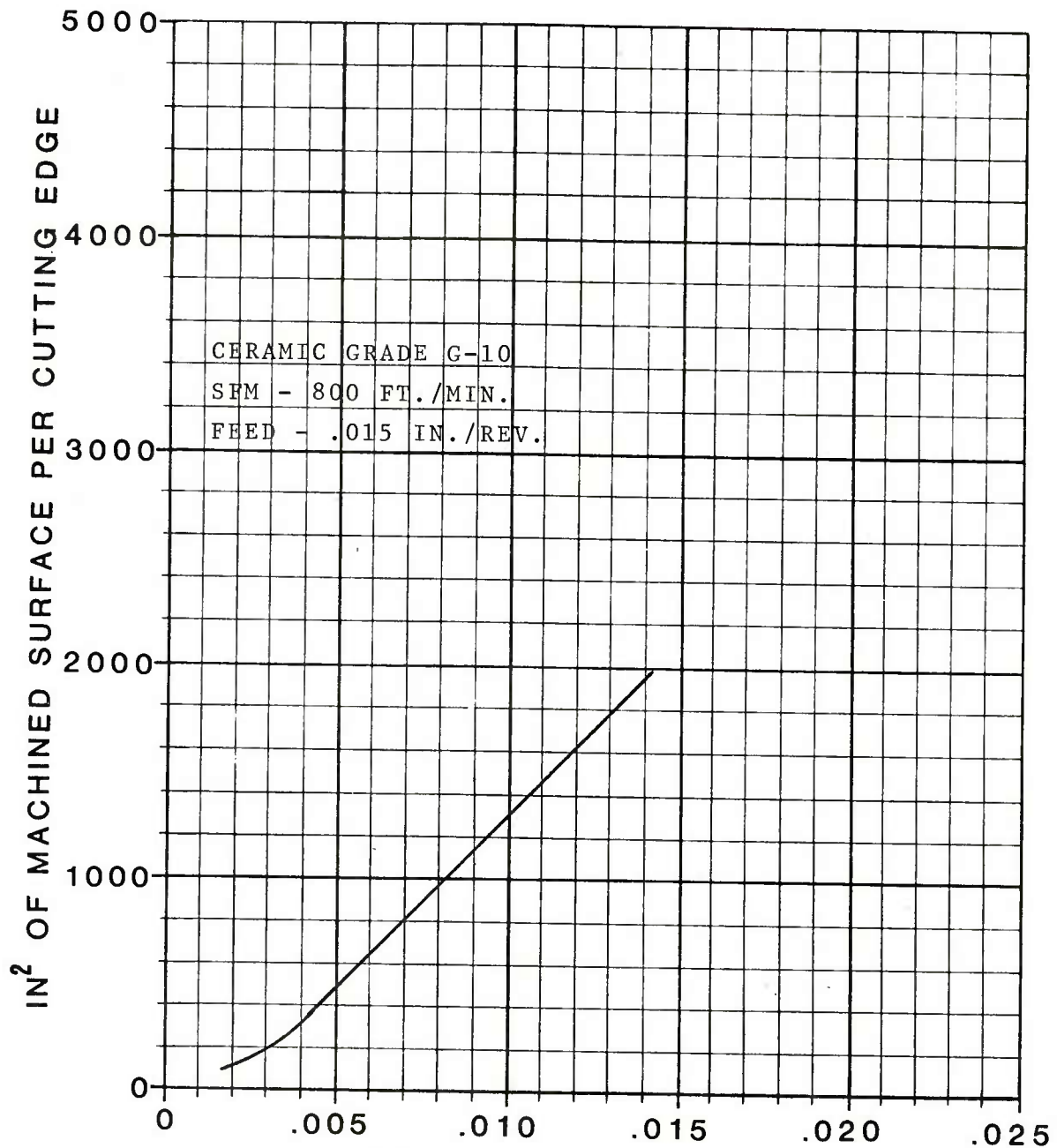
Projectile Material	- 4340
Projectile Hardness Range	- 228/321 BHN (21/34 $R_c$ )
Depth of Cut (approx.)	- .100
Tool Holder	- CTANR - 164
Insert	- TNMG-433E-48
For Curve Data see tables 91 to 102 - Pages 158 to 169	



**FIGURE 19: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	4340
Projectile Hardness Range	-	228/286 BHN (21/29 R <sub>c</sub> )
Depth of Cut (approx.)	-	.100
Tool Holder	-	CCGNR-164
Insert	-	CNG-454-820
For Curve Data see tables 103 to 113 - Pages 170 to 180		



**FIGURE 20: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- 4340
Projectile Hardness Range	- 228/255 BHN (21/25 R <sub>c</sub> )
Depth of Cut (approx.)	- .100
Tool Holder	- CCGNR-164
Insert	- CNG-454-820

For Curve Data see tables 118 to 120 - Pages 185 to 187

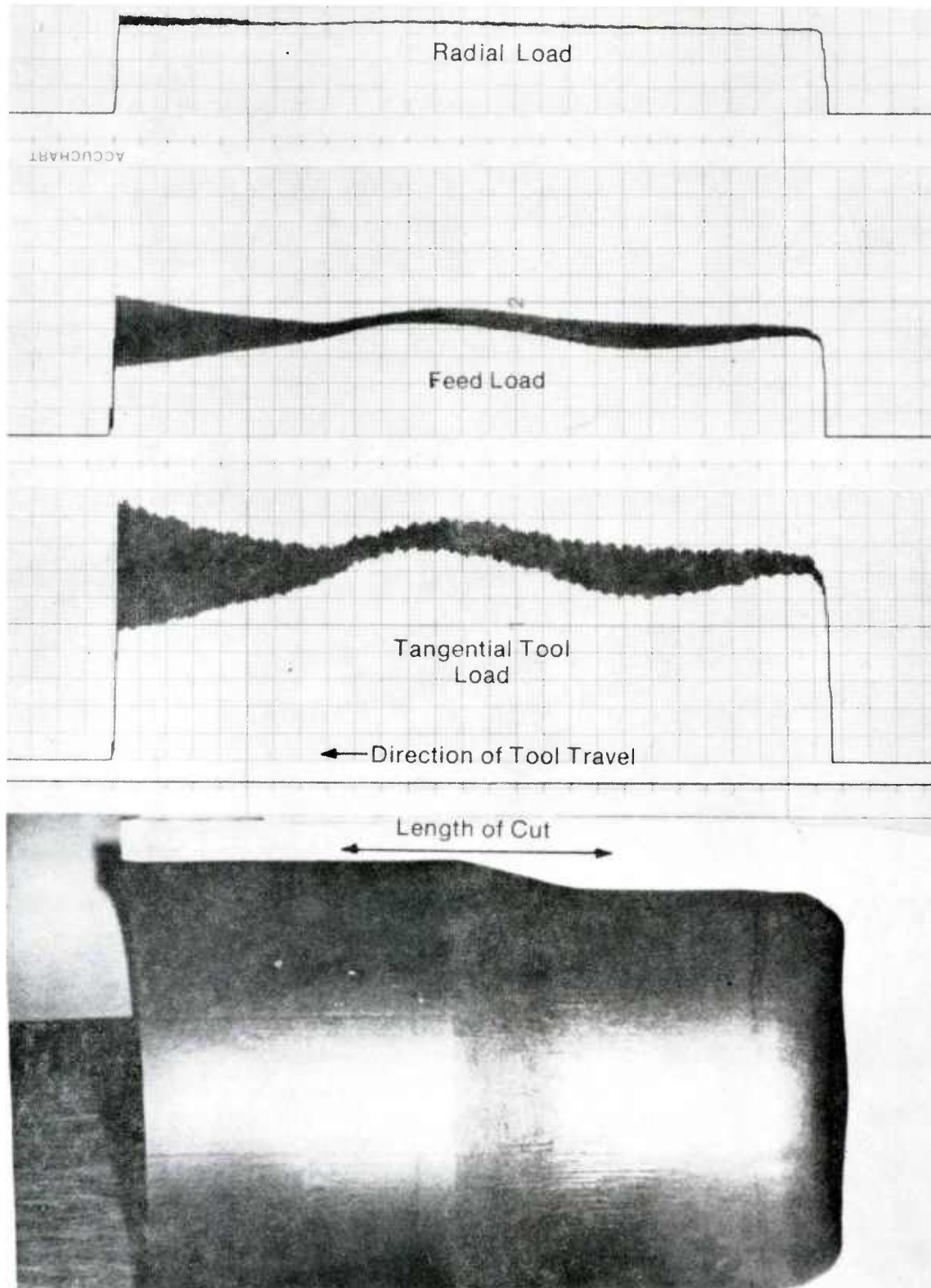


Figure 21:  
Tool Load Charts and Cross-Section of M-549 Motor Bodies showing changes in Tool Loads as Cut progressed thru part.



**4340 MATERIAL - M549 MOTOR BODIES - FINISHING CUTS -  
363 TO 415 BRINELL HARDNESS (39 TO 44.5 RC)**

The hardness range of this material was not the same as any of the other tests conducted on 4340 in the previous part of this effort, therefore some estimates of surface speed had to be made. Using ceramic coated carbide, Grade 570, a cutting speed of 350 feet per minute was tested, and an area of 700 square inches of surface was machined. The cutting speed was lowered to 300 and 325 feet per minute and tests run, so the wear-land versus machined area charts could be made. The wear-land of 0.012 inches was selected, as an end-point, for all three cutting speeds. These three curves are plotted on Figure 23, Page 41. Data from this chart, along with other tests, were used to plot the tool life-line on Figure 22, Page 40.

The interesting feature of this graph, Figure 23, shows that an 8% increase in cutting speed (300 to 325 feet per minute) results in a 54% reduction in tool life, and a 17% increase in cutting speed (300 to 350 feet per minute) results in a 73% reduction in tool life. To highlight these figures in another way, if a part had a machined area of 100 square inches, and the cutting speed was 300 feet per minute, 26 pieces could be machined per cutting edge, but if the cutting speed was increased to 325 feet per minute, only 12 parts could be machined per cutting edge, and if the speed was increased to 350 feet per minute, only 7 parts could be machined per cutting edge.

The previous study did not furnish guidelines for surface speed to use on this material. Various cutting speeds using ceramic inserts were tried, with little or no success. A problem of "notching" at the junction of the nose radius and end cutting edge angle caused concern.

This notching appeared after one or two motor bodies were turned and was always a progressive type of wear. During the testing, this wear was always larger than the nose or flank wear, and tests were terminated when this value exceeded approximately .020 inches. Any insert failure that occurred was not the result of this wear, but was from other sources. When

this notching occurred, the radial load increased in the first several revolutions of the work-piece, but stayed constant through the cut. The damage to the insert was caused either by a chip condition at the start of cut or the material in the starting shoulder of the cut. It was not while the tool was cutting, because there was no indication from the tool loads.

A series of tests were made in which different ceramic tool grades, nose radius, and tool holder variations were used. The results of these tests are shown below and the photographs of the inserts are shown on Page 43. The photographs show this "notching", and effects of changing nose radius and tool geometry. The largest change took place when a lead angle was put on the tool holder.

PHOTO NO.	CERAMIC GRADE	INSERT NO.	SFM FEED	HOLDER	WEAR* LAND
1	G-10	CNG-454-820	450 0.015	1	0.020
2	G-30	CNG-454-820	450 0.015	1	0.020
3	G-10	CNG-454-820	450 0.015	2	0.018
4	G-10	CNG-454-820	450 0.015	3	0.0055
5	G-10	CNG-452-630	450 0.015	3	0.007

\* Approximately 700 square inches of machined area.

Holder No. 1 - Standard Holder

Holder No. 2 - 1½° Additional Back Rake

6½° Total Back Rake

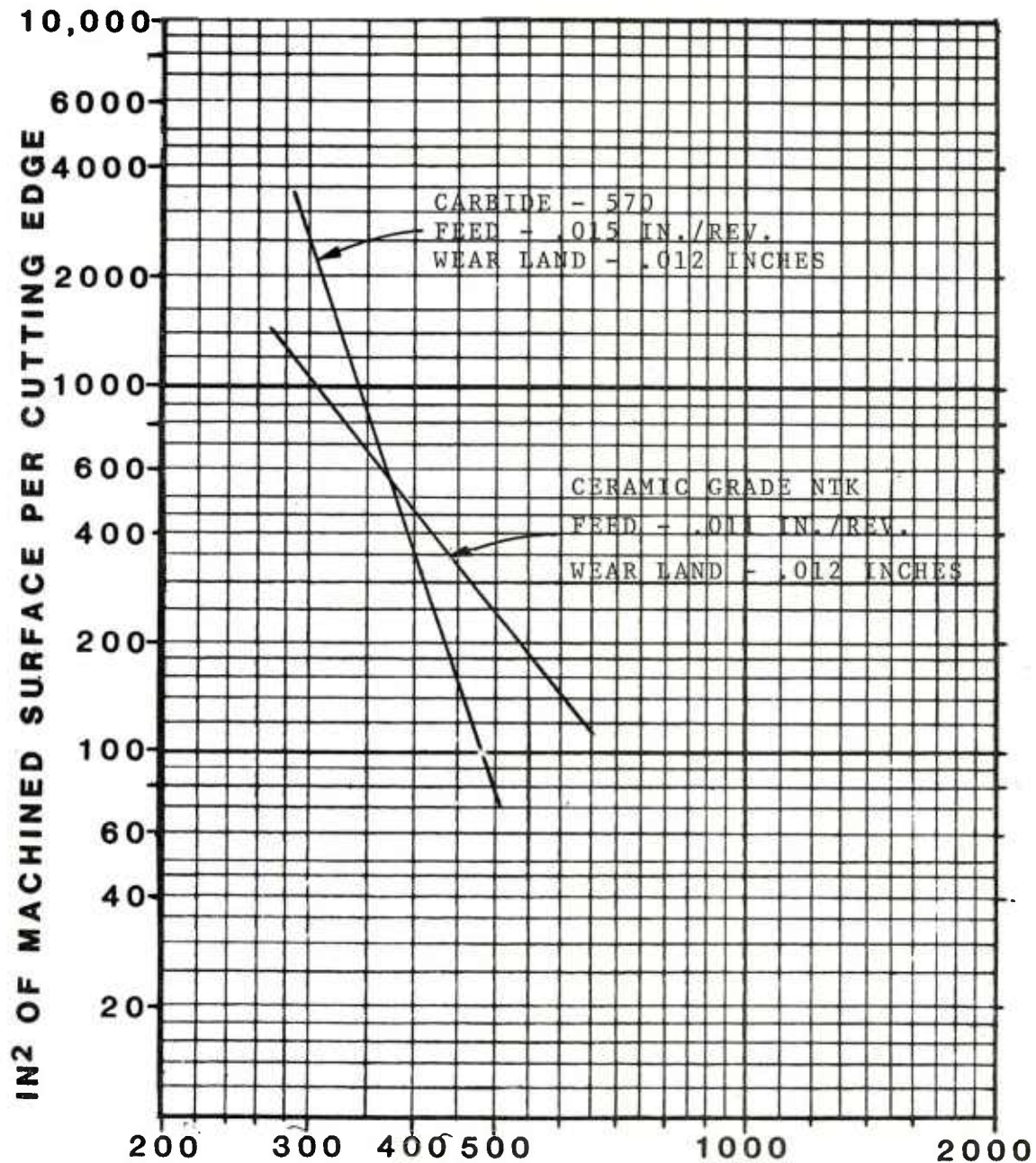
Holder No. 3 - 6½° Back Rake and 5° Positive

Lead Angle



A total holder with a 30° lead angle was used, with a square insert and a 1/8 inch nose radius, with poor results, and no definitive answers. The feed rate was lowered to 0.011 inches per revolution and a CNG-442-820, Grade G-30, insert tried at various surface speeds but chipping and breakage occurred.

A 45° lead angle holder, with a SNG-453-820 insert, Grade NTK, was run at 0.011 inches per revolution feed rate at various surface speeds. The results of these tests are shown on Figure 24, Page 42. From this graph, and other tests, the life-line of this material is shown on Figure 22, Page 40. This graph shows that ceramic coated carbide is a better cutting tool material than ceramic to use on this material. Further tests on this material could not be conducted because all available material was consumed in tests and the results of the turning cuts with ceramic tooling leave many unanswered questions. Further tests are needed to find the best cutting conditions of ceramic tooling for this material. The Data for all the above tests are found in Table 123 to Table 161, Page 193 to 231.



**FIGURE 22: CUTTING SPEED - FEET PER MINUTE**

TOOL LIFE-LINES OF LISTED CUTTING MATERIAL ON 4340  
STEEL AT 363/415 BRINELL HARDNESS (39 TO 44.5  $R_C$ )

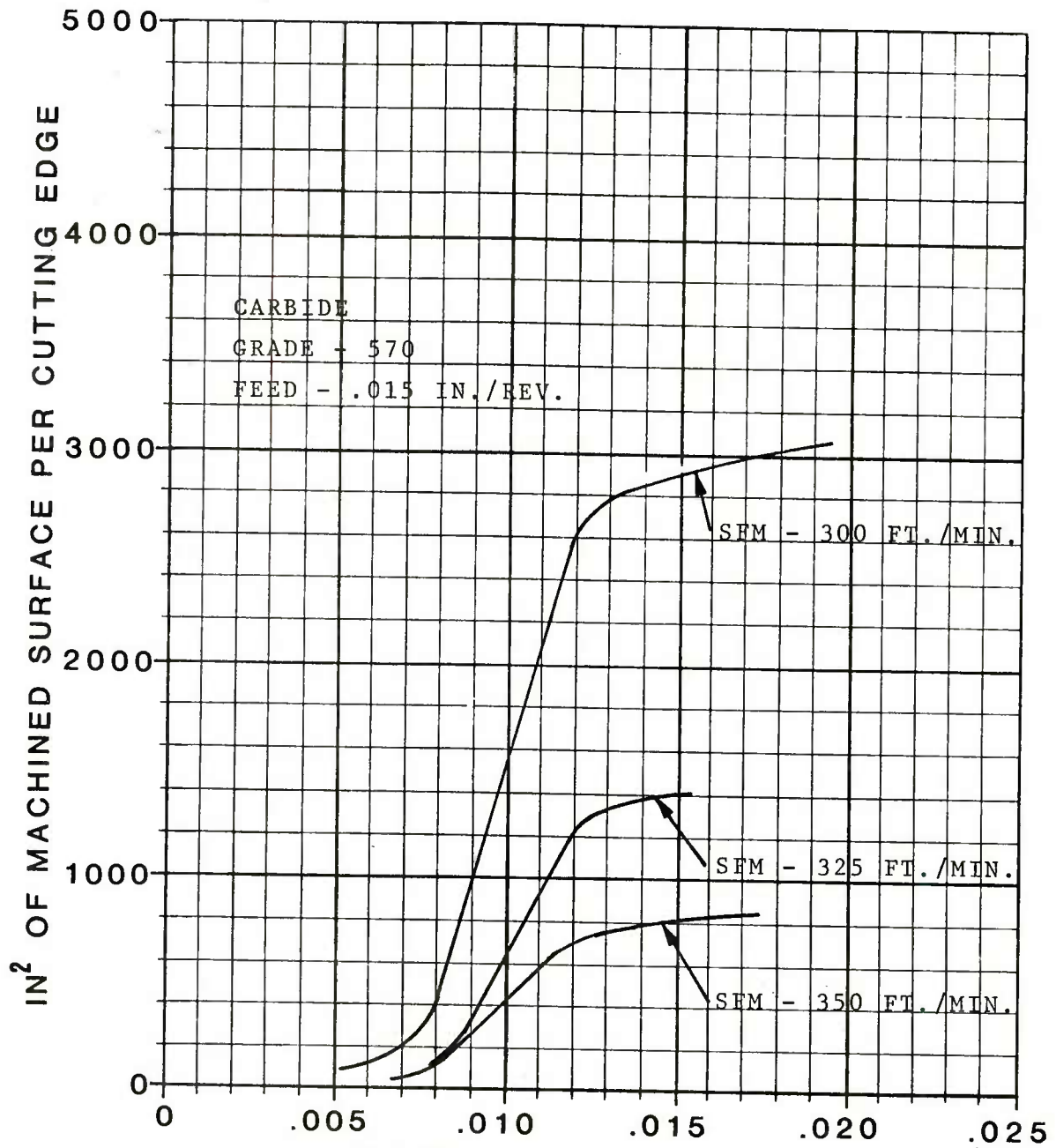
DEPTH OF CUT - .050 INCHES

HOLDER (570) - CTANR-164 ( $0^\circ$  LEAD ANGLE)

INSERT (570) - TNMG-433

HOLDER (NTK) - CSDNN-164 ( $45^\circ$  LEAD ANGLE)

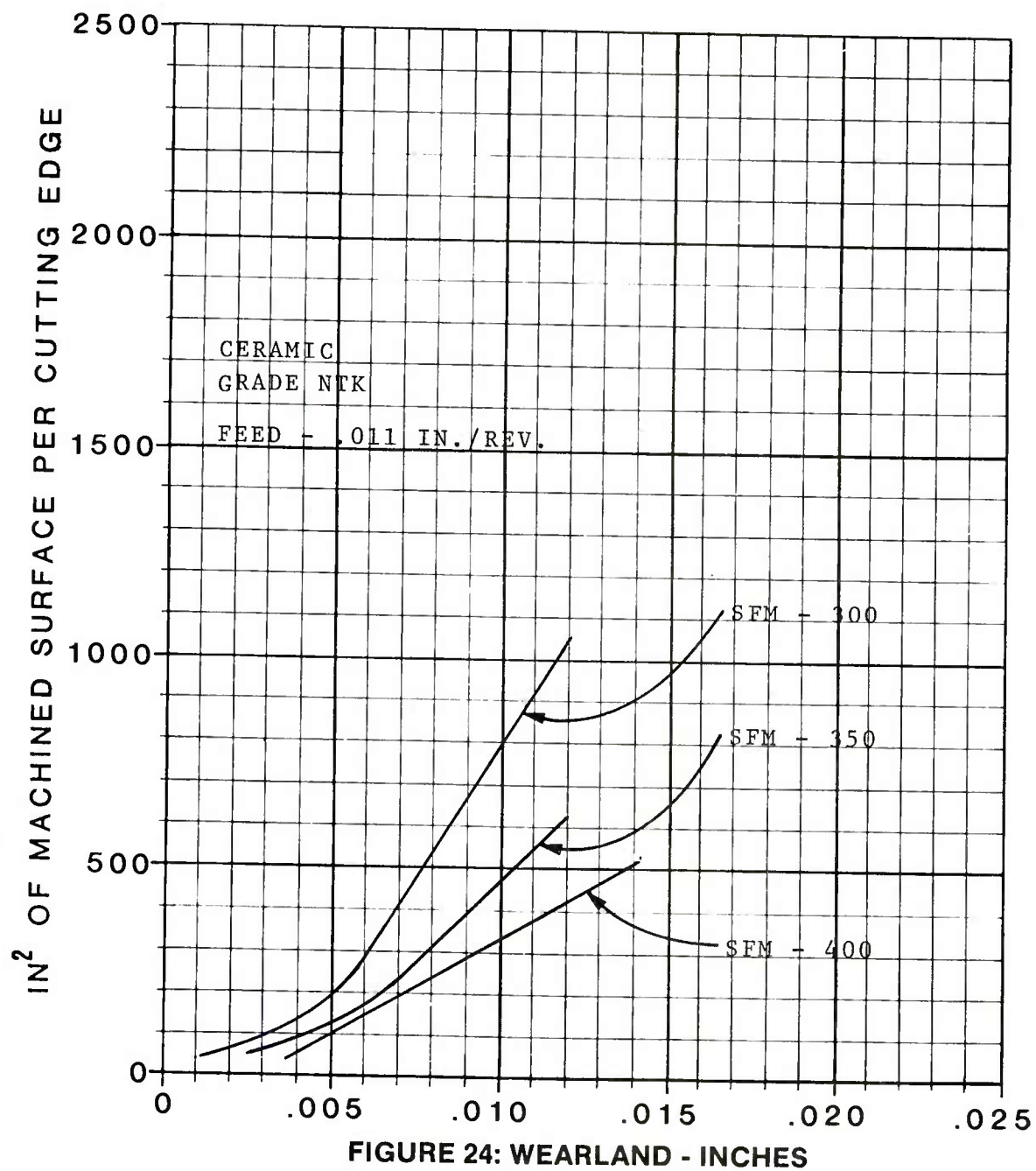
INSERT (NTK) - SNG-453-820



**FIGURE 23: WEARLAND - INCHES**

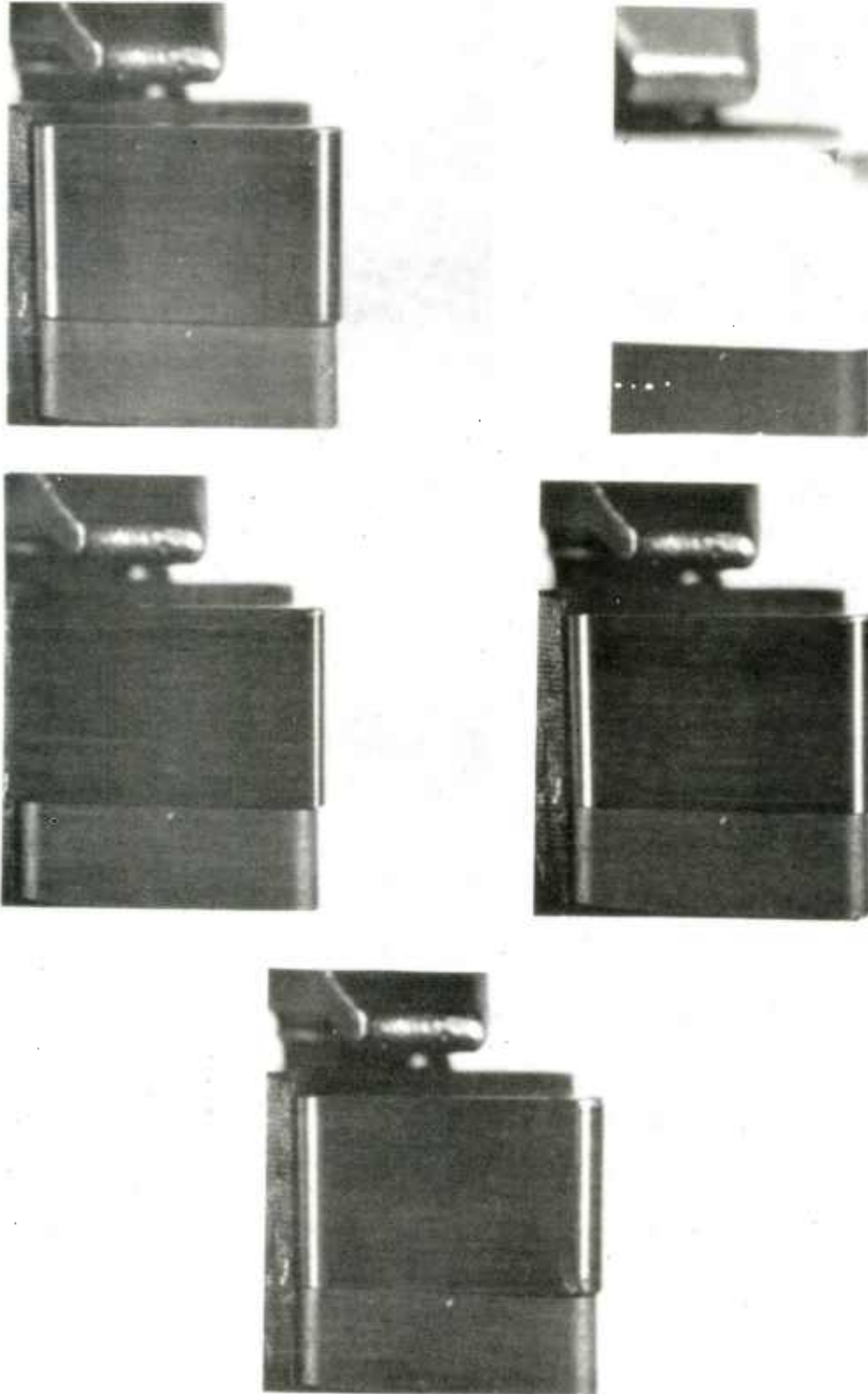
Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material - 4340  
 Projectile Hardness Range - 363/415 BHN. (39/44.5 R<sub>c</sub>)  
 Depth of Cut (approx.) - .050 INCHES  
 Tool Holder - CTANR - 164  
 Insert - TNMG-433-E48  
 For Curve Data see tables 124 to 131 - Pages 194 to 201



Wear-Land Curve for Listed Tool Materials  
and Projectile Materials.

Projectile Material - 4340  
 Projectile Hardness Range - 363/415 BHN (38/43 Rc)  
 Depth of Cut (approx.) - .050 INCHES  
 Tool Holder - CSDNN - 164 (45° LEAD ANGLE)  
 Insert - SNG-453-820  
 For Curve Data see tables 155 to 160 - Pages 225 to 230



**FIGURE 25:**  
Photographs showing Wear-Land on rear of Nose Radius



## **HF-1 MATERIAL - XM795 PROJECTILE FORGINGS - ROUGHING CUTS - 255/302 BRINELL HARDNESS (25/31 RC)**

Ceramic-coated carbide, Carboloy Grade 570, was used for these tests starting at 420 surface feet per minute and 0.022 inches per revolution feed. This set of conditions did not give repeatable results. After a discussion of cutting temperature with a representative of Carboloy, the cutting speed was then lowered to 400 feet per minute. The results of two successive runs are plotted on Figure 27, Page 47. A value of 0.018 inches wear-land and 3,000 square inches of machined area was used as a point on the log-log tool-life line. Figure 26, Page 46. The chip condition was a single roll  $\frac{1}{4}$ " diameter.

The hot-press ceramic, G-10, was tested using 640 feet per minute and 0.015 inches per revolution feed as the cutting parameters. The cutting speed was too fast to generate 2,500 square inches of machined area, so it was lowered to 600 feet per minute. The results of two successive runs are plotted on Figure 28, Page 48. A value of 2,500 square inches of machined surface at 0.015 inches wear-land, and other data from previous tests were used to plot the life-line on Figure 26, Page 46.

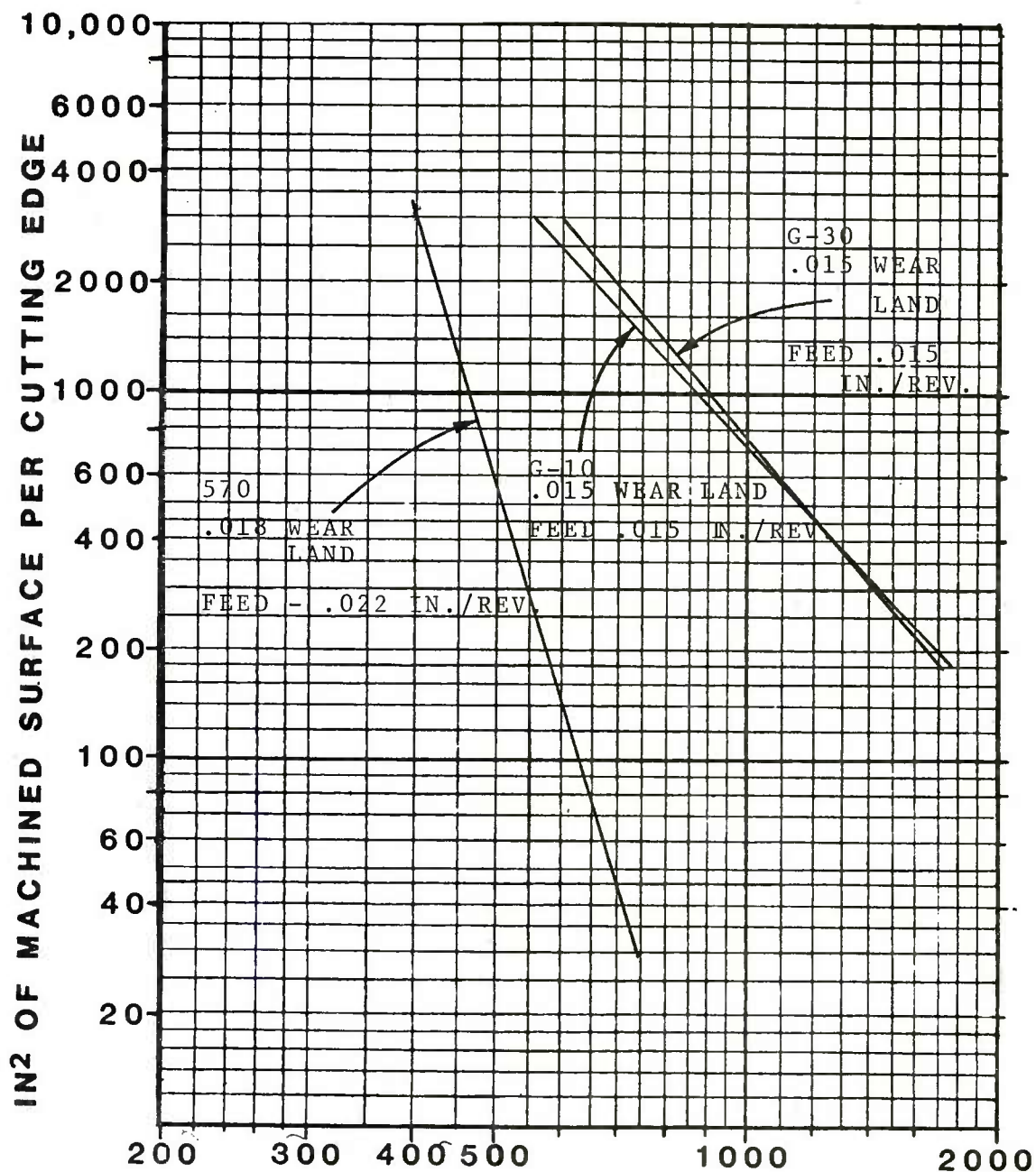
The feed rate was increased to 0.022 inches per revolution and tried at various cutting speeds, but chipping and breakage occurred, so these tests were determined to be failures. Pictures showing the top face of two G-10 inserts operating at 0.022 inches per revolution feed rate are shown in Figure 30, Page 50. The extent of "cracking" of the insert can clearly be seen.

Cold-press ceramic, G-30, was tested at 630 feet per minute and 0.015 inches per revolution feed for two successive runs. The results are plotted on Figure 29, Page 49. This chart confirms that under these conditions a cutting edge will generate 2,500 square inches of machined area, while developing a 0.015 in wear-land. The value of 2,500 square inches of machined surface at a wear-land of 0.015 inches, and 600 surface feet per minute, along with other points in the previous study was used to plot the life-line on Figure 26, Page 46. The chips for ceramic were the same as with carbide. The material gave good chip conditions.

When the feed-rate of 0.022 inches per revolution was tried with G-30, there was

excessive chatter, chipped and cracked inserts, so it was determined that this feed-rate was excessive under these conditions. The data sheets for all the above tests can be found in Table 162 to 191, Pages 234 to 263.





**FIGURE 26: CUTTING SPEED - FEET PER MINUTE**

TOOL LIFE-LINES OF LISTED CUTTING MATERIALS ON HF-1  
STEEL AT 255/302 BRINELL HARDNESS (25 TO 31 R<sub>c</sub>)

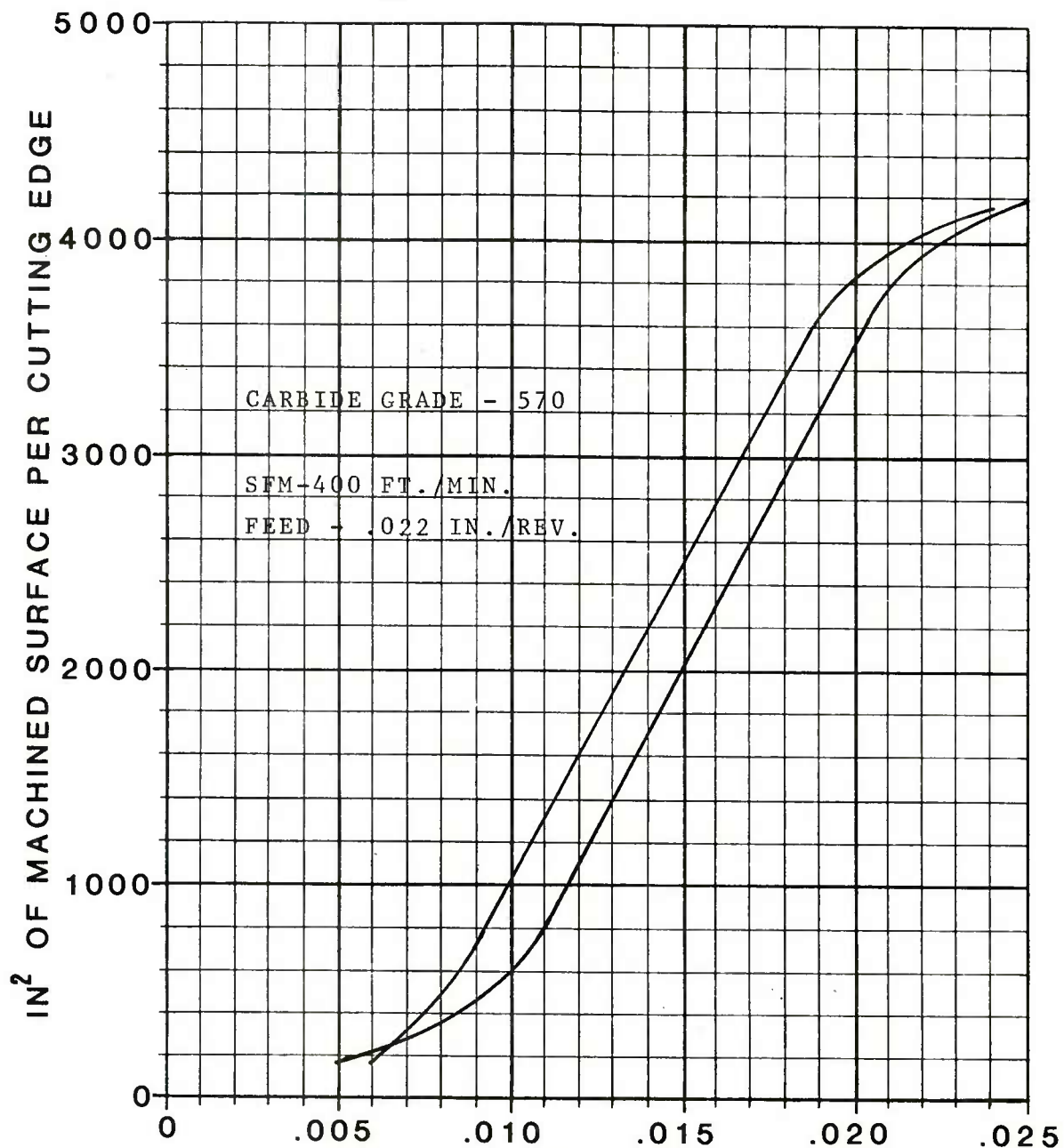
DEPTH OF CUT - .100 INCHES

HOLDER (570) - CTANR-164 (0° LEAD ANGLE)

INSERT (570) - TNMG-433E48

HOLDER (G-10 & G-30) - CCGNR-164 (0° LEAD ANGLE)

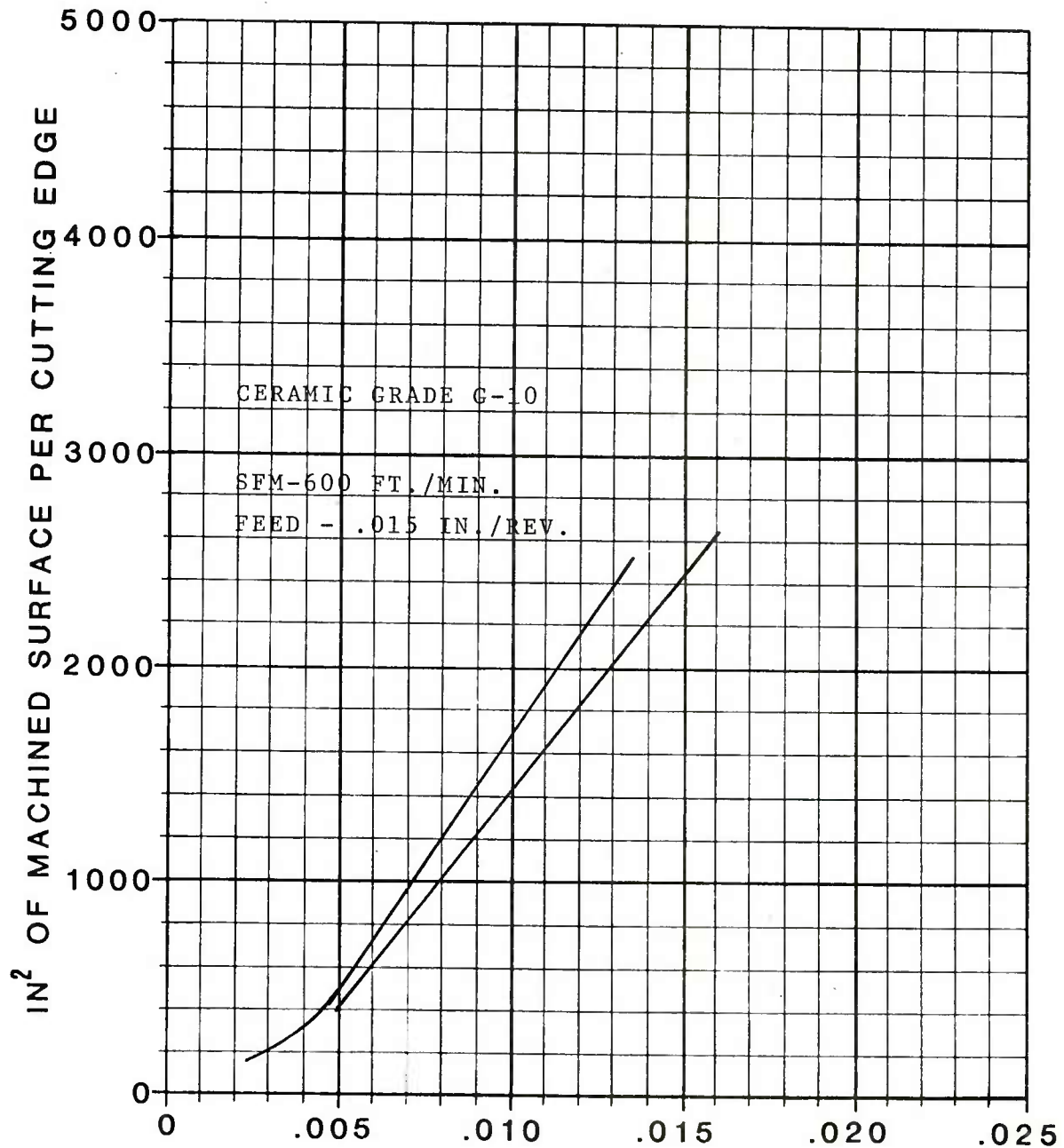
INSERT (G-10 & G-30) - CNG-454-820



**FIGURE 27: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

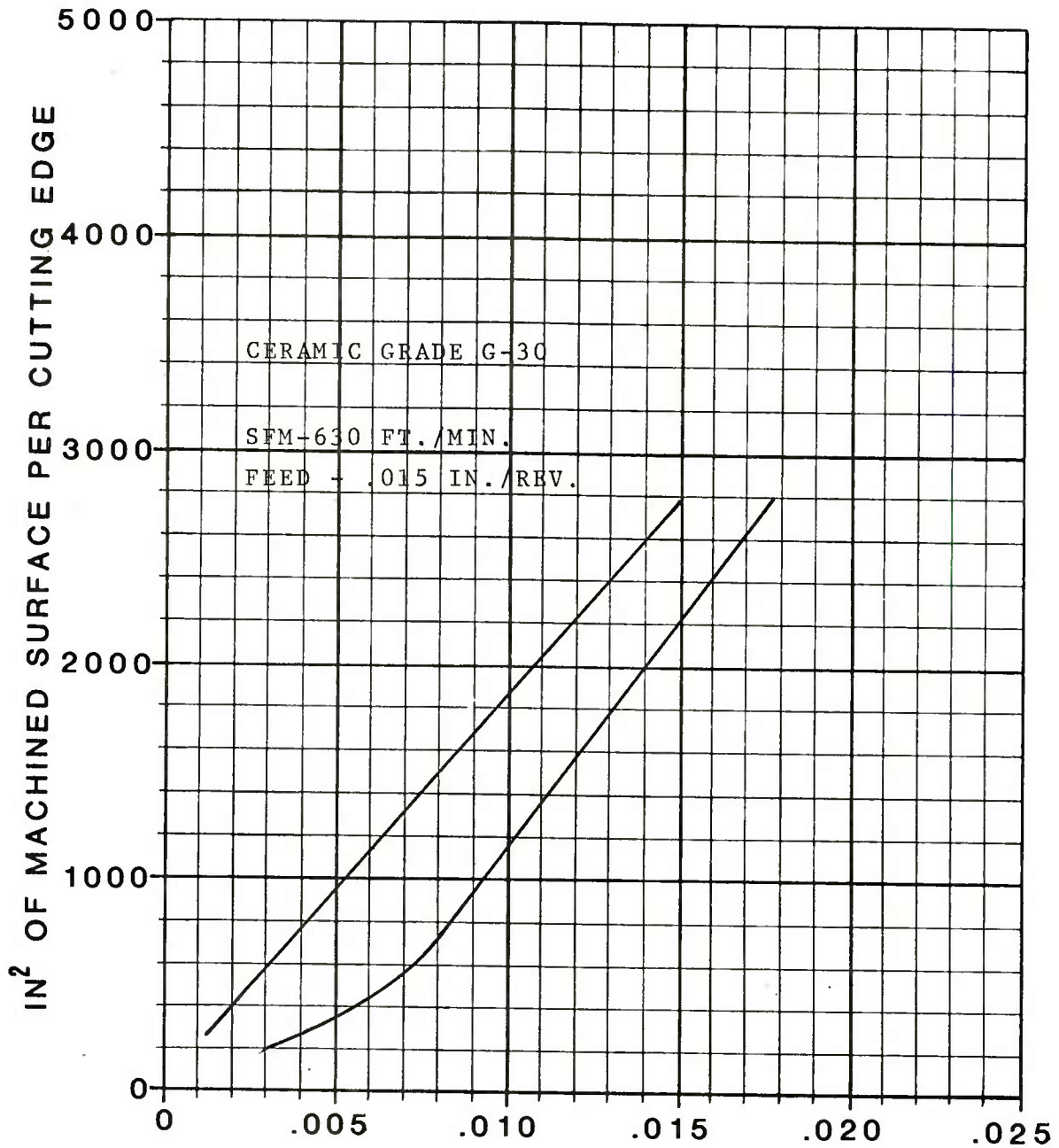
Projectile Material	-	HF-1
Projectile Hardness Range	-	262/302 BHN.
Depth of Cut (approx.)	-	.100 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433E48
For Curve Data see tables 171 to 178 - Pages 243 to 250		



**FIGURE 28: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- HF-1
Projectile Hardness Range	- 269/302 BHN.
Depth of Cut (approx.)	- .100 INCHES
Tool Holder	- CCGNR-164
Insert	- CNG-454-820
For Curve Data see tables 186 to 189 - Pages 258 to 261	

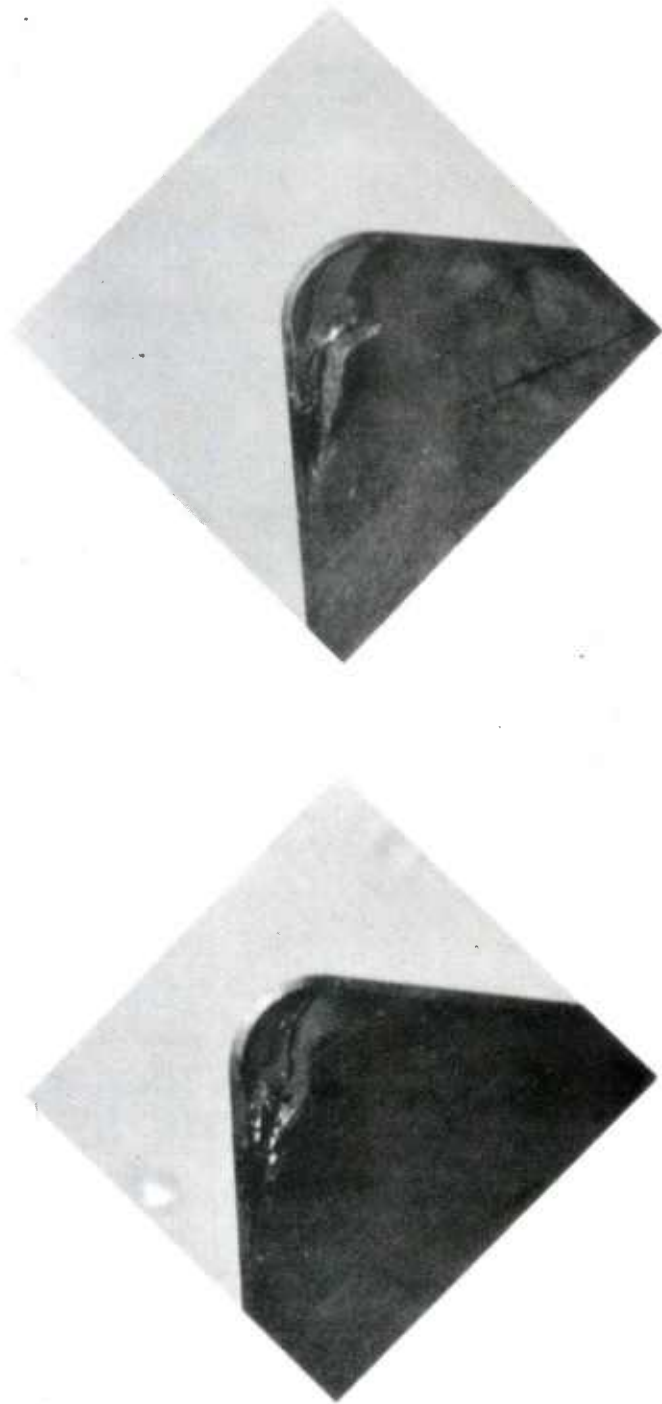


**FIGURE 29: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	HF-1
Projectile Hardness Range	-	269/286 BHN.
Depth of Cut (approx.)	-	.100 INCHES
Tool Holder	-	CCGNR-164
Insert	-	CNG-454-820

For Curve Data see tables 180 to 183 - Pages 252 to 255



**FIGURE 30:**  
Photos showing Cracking of Nose Radius and Top Rake Surfaces of G-10 Inserts.

## **HF-1 MATERIAL - XM795 PROJECTILE FORGINGS - FINISHING CUTS - 286 TO 387 BRINELL HARDNESS (29/41 RC)**

The first part of the study showed a cutting speed of 340 feet per minute, with a feed rate of 0.011 inches per revolution, should be used when taking finishing cuts on this material, with ceramic-coated carbide.

These conditions were tried in two tests and the results are as shown on Figure 32 and 33, Pages 54 and 55. These conditions did not give adequate tool life, so the speed was changed to 320 and 360 surface feet per minute. These changes did not increase tool life before tool failure occurred, as can be seen on Figure 34, Page 56. A test was made using 400 surface feet per minute, but ended in tool breakage, so it was not plotted.

Due to failures and tests with poor tool life, it was determined that another grade of ceramic-coated carbide may give better results, so Kennametals Grade KC-910 was tried. The insert machined 3500 square inches of machined surface while generating a wear-land of .009 inches, this test is shown on Figure 35, Page 57.

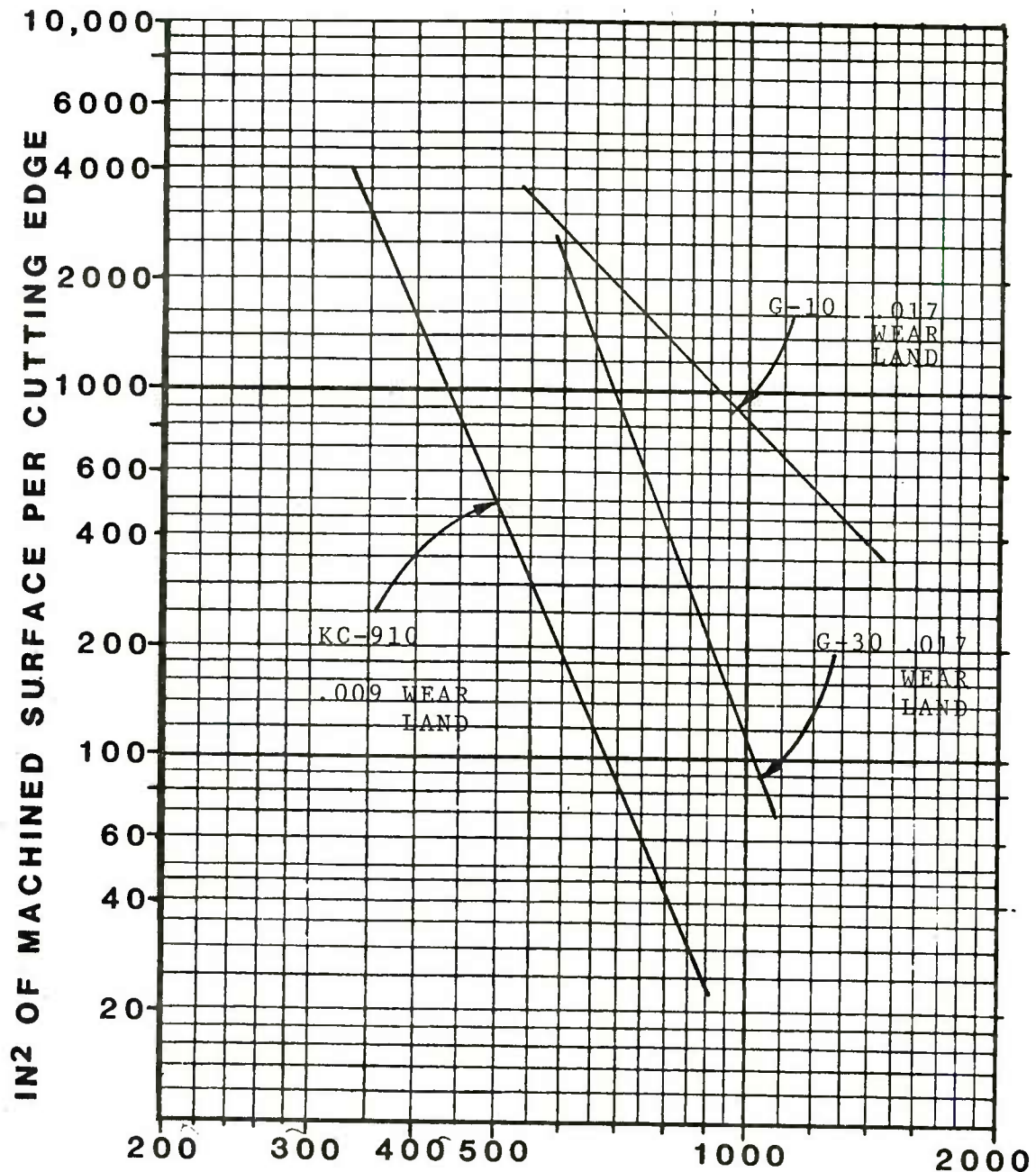
This data, along with other tests, was used to plot the life-line for this cutting tool material on Figure 31, Page 53.

The previous part of the study showed that cold-press G-30 ceramic should machine these projectiles at 590 feet per minute using a 0.011 inches per revolution feed rate. Tests conducted which showed that the above conditions would generate 2300 and 3000 square inches of machined surface, while developing a wear-land of 0.017 inches. A point of 590 surface feet per minute and 2500 square inches of machined surface, along with points in the previous study were used to plot the life-line on Figure 31, Page 53.

The previous study showed that G-10 hot-pressed ceramic inserts should operate at 610 surface feet per minute at a feed of 0.015 inches per revolution. A test was run using above conditions and the insert wore to a 0.017 inch wear-land, while generating 2600 square inches

of machined surface. The cutting speed was lowered to 550 feet per minute and machined 3600 square inches of machined surface, while a wear-land of 0.017 inches was developed. At these machining conditions, a chip of  $\frac{1}{4}$ " diameter, 6 to 8 inches long was generated. These two tests are plotted on Figure 37, Page 59. The test, at 610 surface feet per minute, was made with a "K" land of  $.006 \times 30^\circ$ , in an effort to alleviate the poor chip condition. The change in "K" land did improve the chip condition, and a chip of  $\frac{1}{4}$ " diameter, single curl was produced. Data obtained in the two above tests, along with data from the previous study was used to plot the life-line on Figure 31, Page 53. The data sheets for all above tests can be found in Tables 192 to 216, Pages 267 to 291.





**FIGURE 31: CUTTING SPEED - FEET PER MINUTE**

TOOL LIFE-LINES OF LISTED CUTTING MATERIALS ON HF-1 STEEL AT 286/364 BRINELL HARDNESS (29 TO 38 R<sub>c</sub>)

FEED - .011 INCHES PER REVOLUTION

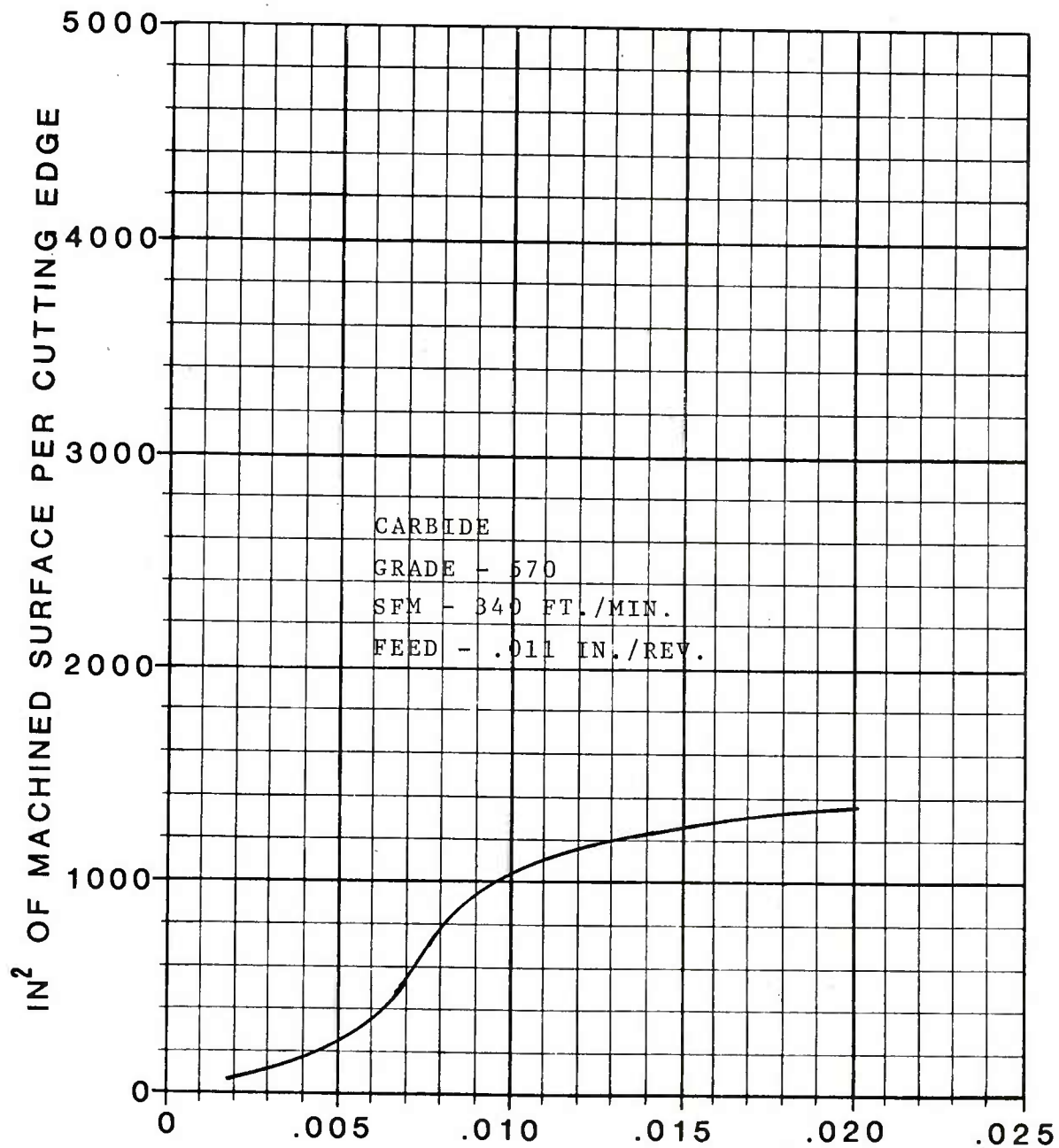
DEPTH OF CUT - .050 INCHES

HOLDER (KC-910) - CTANR-164 (0° LEAD ANGLE)

INSERT (KC-910) - TNMG-433

HOLDER (G-10 & G-30) - CCGNR-164 (0° LEAD ANGLE)

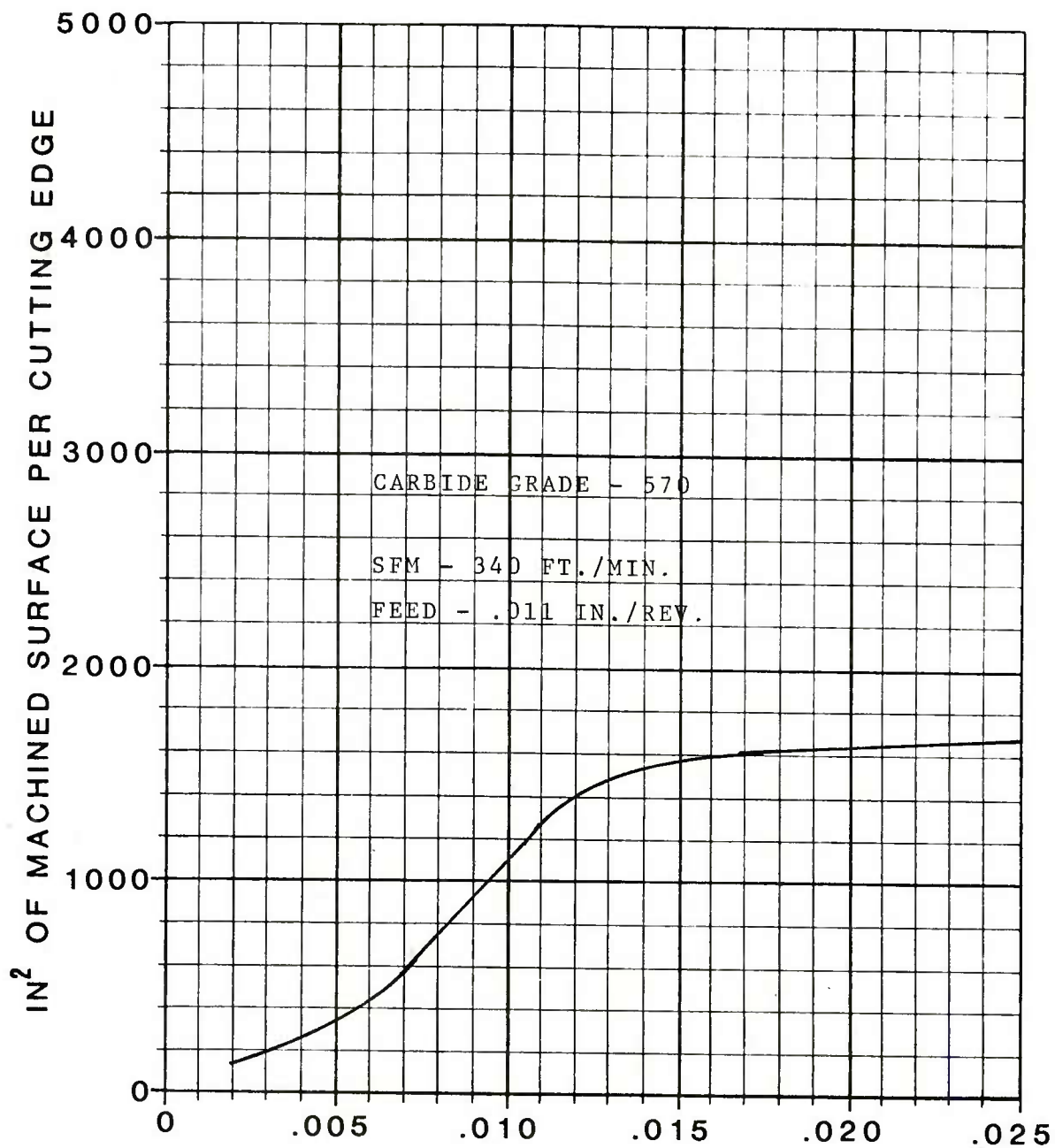
INSERT (G-10 & G-30) - CNG-454



**FIGURE 32: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

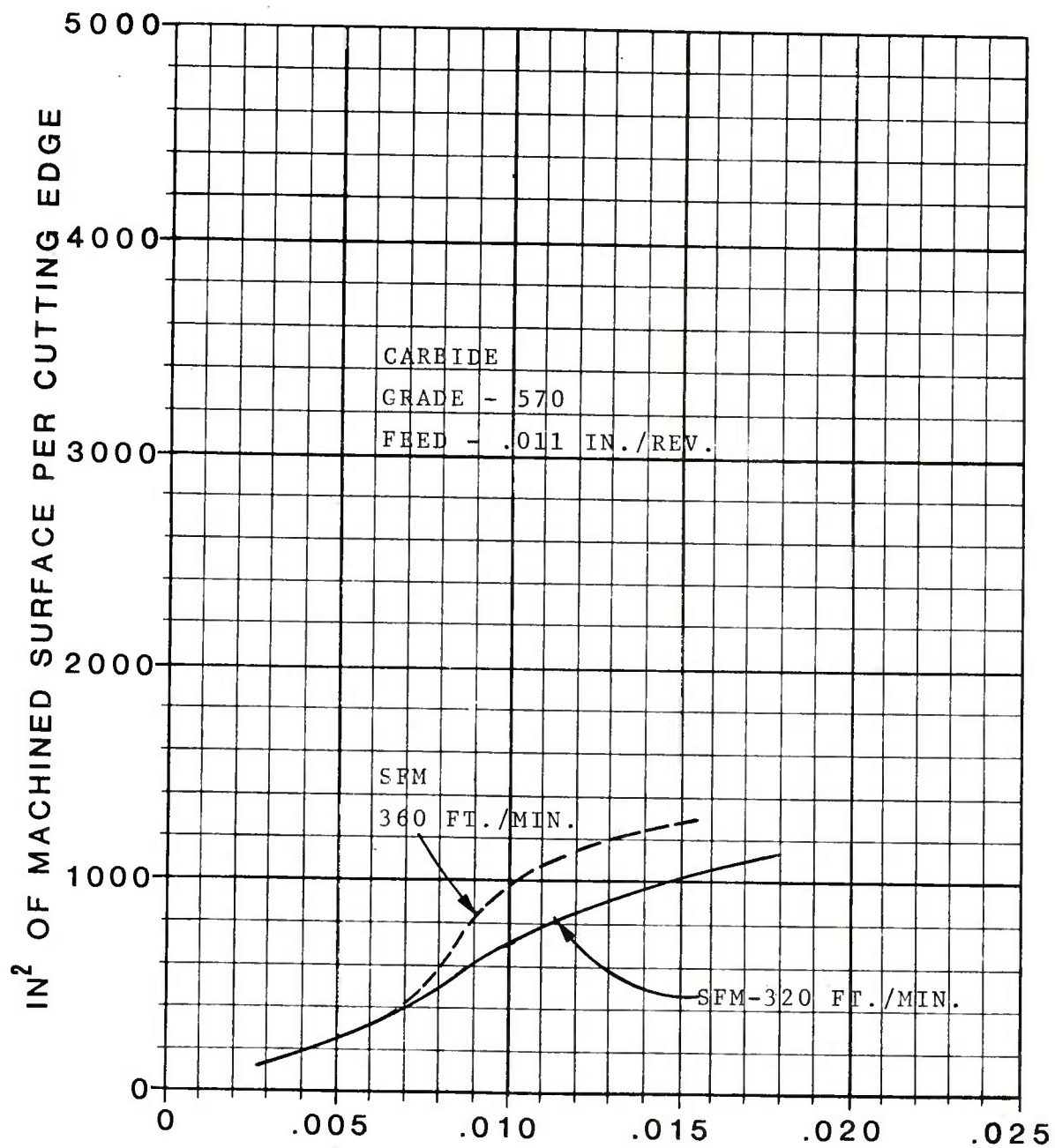
Projectile Material	-	HF-1
Projectile Hardness Range	-	340/364
Depth of Cut (approx.)	-	.050 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433-E48
For Curve Data see table 198 - Pages 273		



**FIGURE 33: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

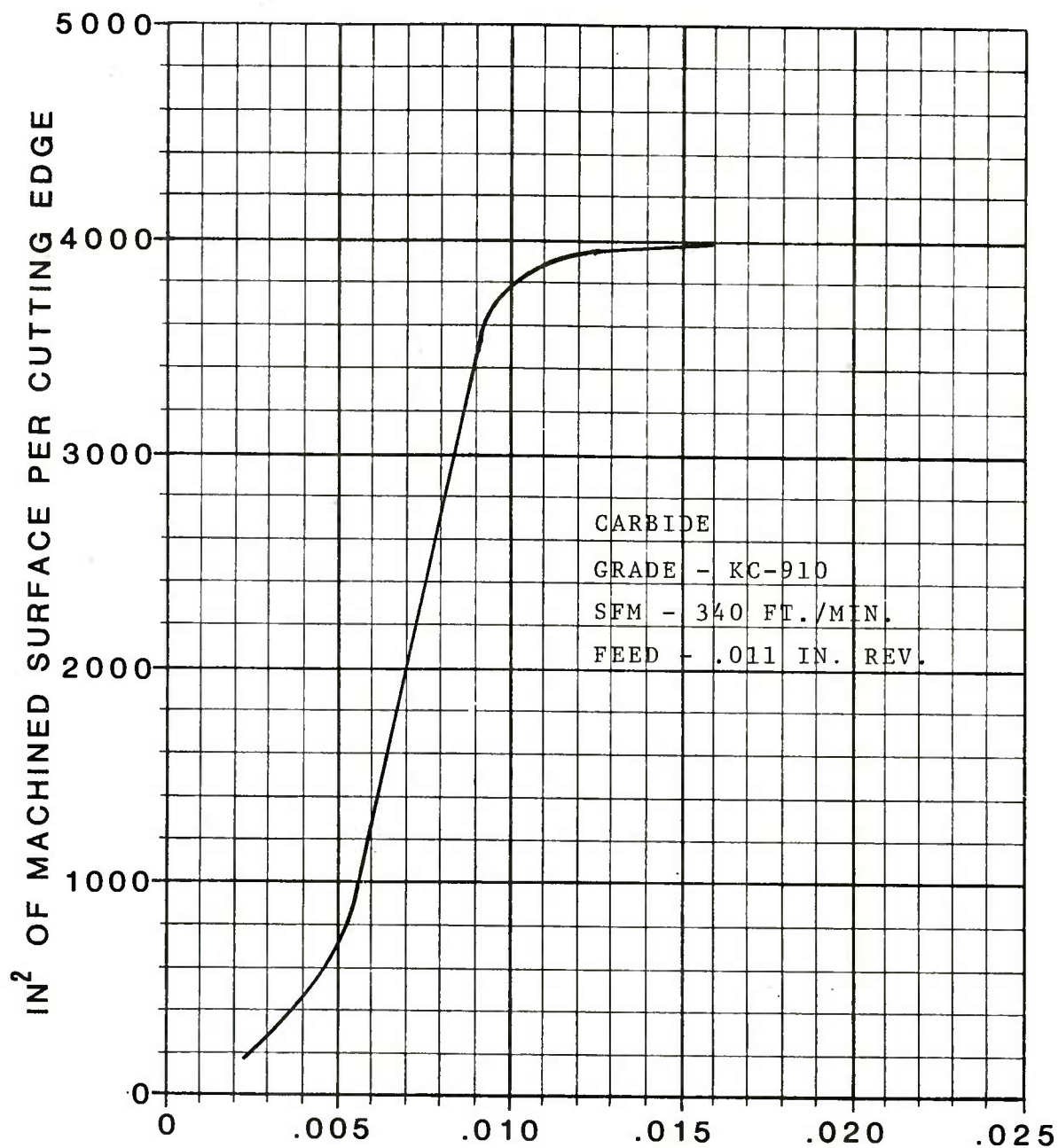
Projectile Material	- HF-1
Projectile Hardness Range	- 340/364 BHN.
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CTANR-164
Insert	- TNMG-433-E48
For Curve Data see table 194 - Pages 269	



**FIGURE 34: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

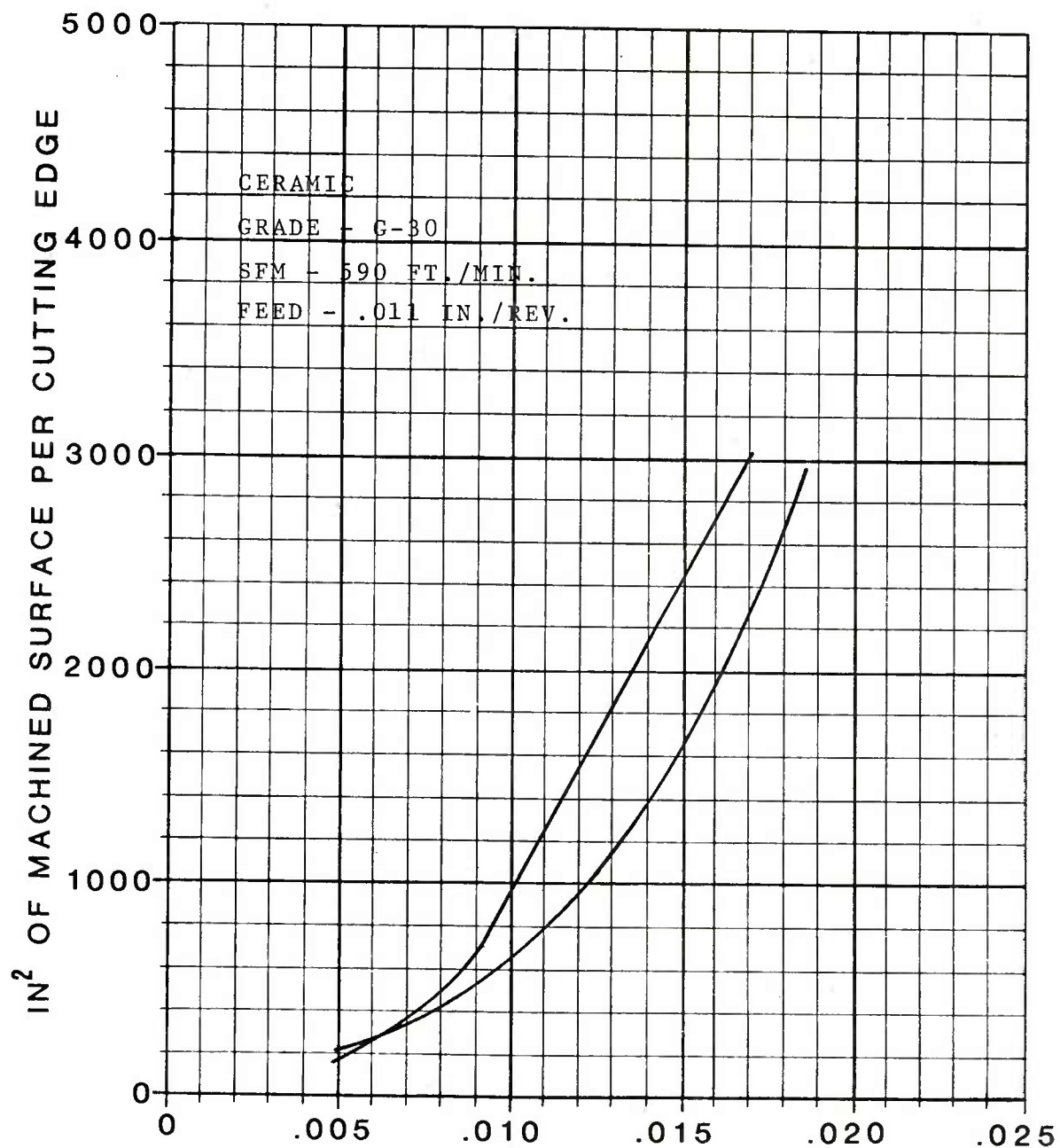
Projectile Material	-	HF-1
Projectile Hardness Range	-	340/364 BHN.
Depth of Cut (approx.)	-	.050 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433-E48
For Curve Data see tables 195 to 196 - Pages 270 to 271		



**FIGURE 35: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	-	HF-1
Projectile Hardness Range	-	340/364 BHN.
Depth of Cut (approx.)	-	.050 INCHES
Tool Holder	-	CTANR-164
Insert	-	TNMG-433
For Curve Data see tables 200 to 202 - Pages 275 to 277		

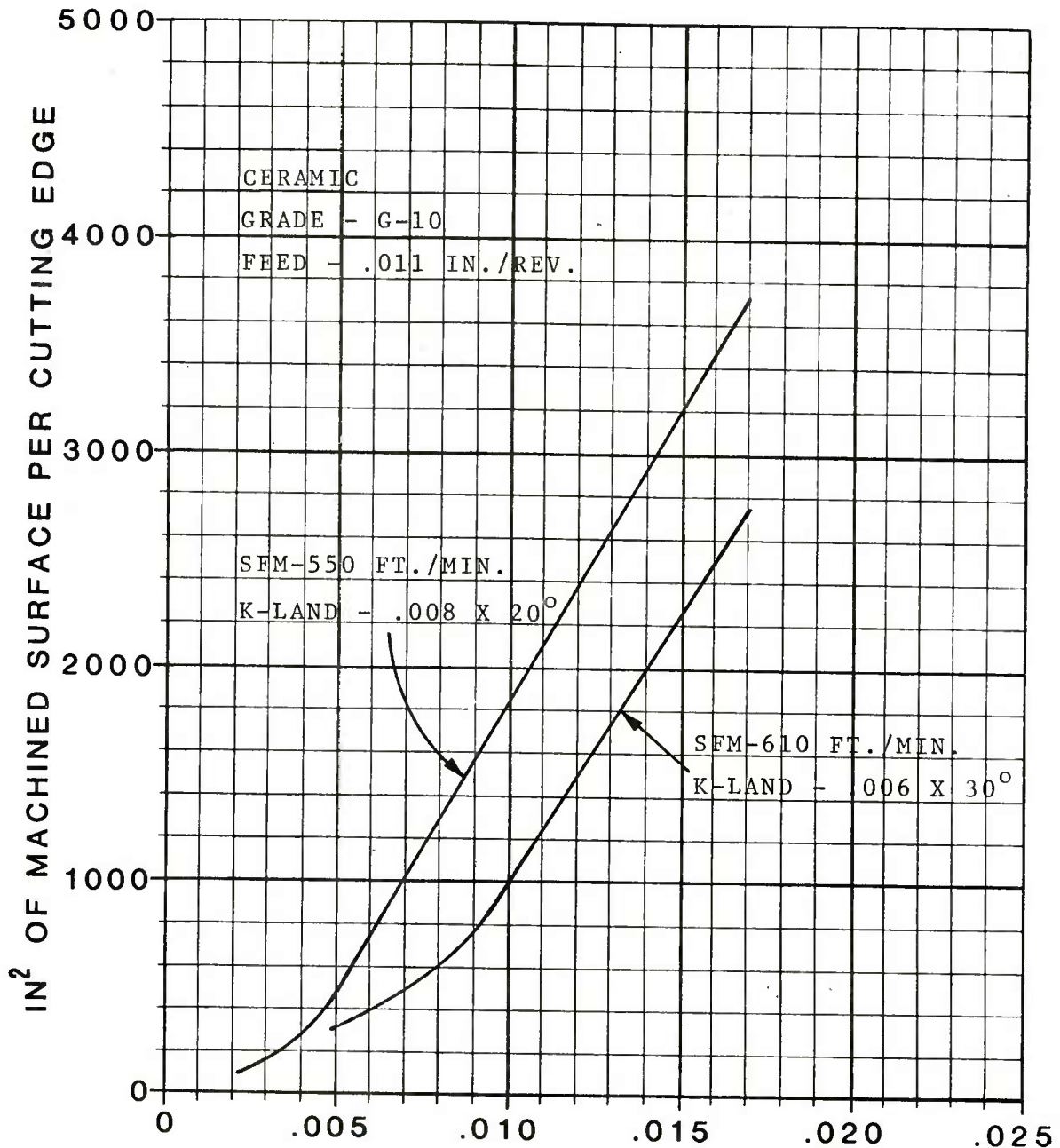


**FIGURE 36: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- HF-1
Projectile Hardness Range	- 286/387 BHN.
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CCGNR-164
Insert	- CNG-454 - 630
For Curve Data see tables 203 to 209 - Pages 278 to 284	





**FIGURE 37: WEARLAND - INCHES**

Wear-Land Curve for Listed Tool Materials and Projectile Materials

Projectile Material	- HF-1
Projectile Hardness Range	- 340/364 BHN.
Depth of Cut (approx.)	- .050 INCHES
Tool Holder	- CCGNR-164
Insert	- CNG-454 - FOR "K" LAND SEE CHART

For Curve Data see tables 210 to 215 - Pages 285 to 290

<b>Date:</b> 12/11/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100"	<b>Coolant:</b>
<b>Hardness:</b> 207/286 BHN.	<b>Tool Description:</b>
<b>Coolant Application:</b>	<b>Holder:</b> SEE FIGURE
	<b>Insert:</b> SEE FIGURE

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				FROM CONFIRMATION TESTS					
1	570	630	.025	-	-	-	2300	.015	2300   .015
				FROM PREVIOUS TESTS					
2	570	850	.025	-	-	-	397.6	.008	746   .015
3	570	1100	.025	-	-	-	117	.0065	270   .015
4	570	1200	.025	-	-	-	125	.0175	107   .015
				FROM CONFIRMATION TEST					
1	G-30	870	.015				3100	.014	3100   .014
				FROM PREVIOUS TESTS					
2	G-30	1400	.015	-	-	-	276	.006	644   .014
3	G-30	1100	.015	-	-	-	363	.0052	977   .014
4	G-30	1000	.015	-	-	-	700	.0065	1508   .014

**NOTES:**

**TABLE 3: DATA FOR LIFE LINES**

<b>Date:</b> 10/29/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b>	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 217			BHN.		
1	570	700	.025	-	6.139	6.000	115.7	.003	NOTE 1
2	570	700	.025	-	6.139	6.000	115.7 231 T.	.005	NOTE 2
3	570	700	.025	-	6.139	6.000	115.7 347 T.	.0075	
				PROJECTILE HARDNESS - 228			241 BHN.		
4	570	700	.025	-	6.151	6.000	115.9 463 T.	.0085	
5	570	700	.025	-	6.151	6.000	115.9 579 T.	.010	
6	570	700	.025	-	6.151	6.000	115.9 695 T.	.0105	
				PROJECTILE HARDNESS 217/228			BHN.		
7	570	700	.025		6.051	6.000	114. 809 T.	.013	
8	570	700	.025		6.051	12.000	228 1037 T.	.017	NOTE 3

**NOTES:**

1. Chip in flank - approx .25" from nose radius
2. Wear on flank - tight thick chips
3. Excessive wear - test stopped - cutting conditions changed

**TABLE 4: DATA FOR LIFE LINES**

<b>Date:</b> 10/30/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228/240 BHN.					
1	570	630	.025	-	6.172	6.000	116	.0045	
2	570	630	.025	-	6.172	6.000	116 232 T.	.006	
3	570	630	.025	-	6.172	6.000	116 348 T.	.007	
				PROJECTILE HARDNESS - 217/228 BHN					
4	570	630	.025	-	6.116	6.000	115 463 T.	.008	
5	570	630	.025	-	6.116	12.000	231 694 T.	.0085	
				PROJECTILE HARDNESS - 207/217 BHN.					
6	570	630	.025	-	6.140	6.000	115.7 810 T.	.0085	
7	570	630	.025	-	6.140	12.000	231.4 1041 T.	.0085	
				PROJECTILE HARDNESS - 255 BHN.					
8	570	630	.025	-	6.149	6.000	115.9 1157 T.	.0095	
9	570	630	.025	-	6.149	12.000	231.8 1389 T.	.0105	
<b>NOTES:</b>									

**TABLE 5: DATA FOR LIFE LINES**

<b>Date:</b>	10/30/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. - .100"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241 BHN.					
10	570	630	.025	-	6.157	6.000	116 1505 T.	.011	
11	570	630	.025	-	6.157	12.000	232 1737 T.	.0115	
				PROJECTILE HARDNESS - 207/217 BHN.					
12	570	630	.025	-	6.147	18.000	347.6 2085 T.	.012	
				PROJECTILE HARDNESS - 228/241 BHN.					
13	570	630	.025	-	6.145	18.00	347.4 2432 T.	.013	
				PROJECTILE HARDNESS - 228 BHN.					
14	570	630	.025	-	6.146	18.000	347.5 2780 T.	.014	
				PROJECTILE HARDNESS - 241 BHN.					
15	570	630	.025	-	6.147	18.000	347.6 3128 T.	.0165	

**NOTES:**

**TABLE 6: DATA FOR LIFE LINES**

<b>Date:</b> 10/30/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .100"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433-E-48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228 BHN.					
1	570	630	.025	-	6.118	6.000	115.3	.004	
2	570	630	.025	-	6.118	6.000	115.3 231 T.	.0055	
3	570	630	.025	-	6.118	6.000	115.3 346 T.	.006	
				PROJECTILE HARDNESS 241/255 BHN.					
4	570	630	.025	-	6.130	6.000	115.5 462 T.	.007	
5	570	630	.025	-	6.130	6.000	115.5 577 T.	.008	
6	570	630	.025	-	6.130	6.000	115.5 693 T.	.0085	
				PROJECTILE HARDNESS - 228 BHN.					
7	570	630	.025	-	6.159	6.000	116 809 T.	.009	
8	570	630	.025	-	6.159	12.000	231 1041 T.	.0095	
				PROJECTILE HARDNESS - 241 BHN.					
9	570	630	.025	-	6.115	18.000	346 1387 T.	.011	

**NOTES:**

TABLE 7: DATA FOR LIFE LINES



<b>Date:</b>	10/30/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 217/228 BHN.					
10	570	630	.025	-	6.096	18.000	344.7 1732 T.	.0125	
				PROJECTILE HARDNESS - 228 BHN.					
11	570	630	.025	-	6.175	18.000	349 2081 T.	.0145 N.	NOTE 1
				PROJECTILE HARDNESS - 217/228 BHN.					
12	570	630	.025	-	6.136	18.000	346.9 2428 T.	.016 N.	
				PROJECTILE HARDNESS - 228 BHN.					
13	570	630	.025	-	6.135	7.300	140.7 2569 T.	.023 N.	

**NOTES:**

1. Runs 11 thru 13 - nose wear was more than flank wear

**TABLE 8: DATA FOR LIFE LINES**

<b>Date:</b>	11/2/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228		BHN.			
1	570	600	.025	-	6.138	4.800	92.6	.0025	
2	570	600	.025	-	6.138	6.000	115.7 208 T.	.006	
				PROJECTILE HARDNESS - 241		BHN.			
3	570	600	.025	-	6.148	9.000	173.8 382 T.	.007	
4	570	600	.025	-	6.148	9.000	173.8 556 T.	.008	
				PROJECTILE HARDNESS 241/255		BHN.			
5	570	600	.025	-	6.129	9.000	173.3 729 T.	.008	
6	570	600	.025	-	6.129	9.000	173.3 902 T.	.009	
				PROJECTILE HARDNESS - 228/241		BHN.			
7	570	600	.025	-	6.160	9.000	174 1076 T.	.009	
8	570	600	.025	-	6.160	9.000	174 1250 T.	.012 N.	NOTE 1

**NOTES:**

1. Nose wear

**TABLE 9: DATA FOR LIFE LINES**

<b>Date:</b>	11/2/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 269			BHN.		
9	570	600	.025	-	6.151	9.000	174 1424 T.	.012 N.	
10	570	600	.025	-	6.151	9.000	174 1598 T.	.013 N.	
				PROJECTILE HARDNESS - 255			BHN.		
11	570	600	.025	-	6.143	9.000	173.7 1772 T.	.0185	NOTE 1

**NOTES:**

1. Excessive wear increase - test stopped

TABLE 10: DATA FOR LIFE LINES

<b>Date:</b> 11/2/81				<b>Material:</b> 1340			
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> NONE			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> NONE				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-454-820			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241/			255 BHN		
1	G-30	870	.015	-	6.120	9.000	173	.002 W. .002 F.	NOTE 1
2	G-30	870	.015	-	6.120	9.000	173 346 T.	.002 W. .0025 F.	
				PROJECTILE HARDNESS - 241			BHN.		
3	G-30	870	.015	-	6.116	9.000	172.9 519 T.	.003 W. .0035 F.	
4	G-30	870	.015	-	6.116	9.000	172.9 692 T.	.0035 W. .0035 F.	
				PROJECTILE HARDNESS - 241			BHN.		
5	G-30	870	.015	-	6.106	9.000	172.6 865 T.	.004 W. .0045 F.	
6	G-30	870	.015	-	6.106	9.000	172.6 1038 T.	.004 W. .0045 F.	
				PROJECTILE HARDNESS - 286			BHN.		
7	G-30	870	.015	-	6.149	9.000	173.8 1212 T.	.004 W. .005 F.	
8	G-30	870	.015	-	6.149	9.000	173.8 1386 T.	.005 W. .006 F.	

**NOTES:**  
1. "W" denotes wear in "edge of work" area  
"F" wear on flank  
  
Chip condition - 1/2" dia. roll, single roll to 1" long

**TABLE 11: DATA FOR LIFE LINES**

<b>Date:</b> 11/3/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241/255 BHN.					
9	G-30	870	.015	-	6.071	9.000	171.6 1558 T.	.0065 W. .0065 F.	
10	G-30	870	.015	-	6.071	9.000	171.6 1730 T.	.007 W. .0065 F.	
				PROJECTILE HARDNESS - 286 BHN.					
11	G-30	870	.015	-	6.123	9.000	173.1 1903 T.	.008 W. .007 F.	
12	G-30	870	.015	-	6.123	9.000	173.1 2076 T.	.0085 W. .0075 F.	
				PROJECTILE HARDNESS - 286 BHN.					
13	G-30	870	.015	-	6.110	9.000	172.7 2249 T.	.009 W. .008 F.	
14	G-30	870	.015	-	6.110	9.000	172.7 2421 T.	.009 W. .008 F.	
				PROJECTILE HARDNESS - 255/269 BHN.					
15	G-30	870	.015	-	6.130	9.000	173.3 2594 T.	.010 W. .009 F.	
16	G-30	870	.015	-	6.130	9.000	173.3 2768 T.	.010 W. .009 F.	

**NOTES:**

**TABLE 12: DATA FOR LIFE LINES**

<b>Date:</b> 11/4/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241			BHN.		
17	G-30	870	.015	-	6.133	9.000	173.4 2941 T.	.010 W. .009 F.	
18	G-30	870	.015	-	6.133	9.000	173.4 3114 T.	.011 W. .009 F.	
				PROJECTILE HARDNESS - 228			241 BHN.		
19	G-30	870	.015	-	6.105	9.000	172.6 3287 T.	.011 W. .010 F.	
20	G-30	870	.015	-	6.105	9.000	172.6 3459 T.	.012 W. .011 F.	
				PROJECTILE HARDNESS - 228			241 BHN.		
21	G-30	870	.015	-	6.100	9.000	172.5 3631 T.	.012 W. .011 F.	
22	G-30	870	.015	-	6.100	9.000	172.5 3804 T.	.012 W. .011 F.	

**NOTES:**

**TABLE 13: DATA FOR LIFE LINES**



<b>Date:</b>	11/4/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGMR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241/255 BHN.					
1	G-30	870	.015	-	6.122	9.000	173	.002 W. .0015 F.	
2	G-30	870	.015	-	6.122	9.000	173 346 T.	.002 W. .003 F.	
				PROJECTILE HARDNESS 241 BHN.					
3	G-30	870	.015	-	6.126	9.000	173.2 519 T.	.003 W. .003 F.	
4	G-30	870	.015	-	6.126	9.000	173.2 692 T.	.003 W. .0035 F.	
				PROJECTILE HARDNESS - 241/255 BHN.					
5	G-30	870	.015	-	6.119	9.000	173 865 T.	.004 W. .004 F.	
6	G-30	870	.015	-	6.119	9.000	173 1038 T.	.005 W. .0045 F.	
				PROJECTILE HARDNESS - 241/255 BHN.					
7	G-30	870	.015	-	6.211	9.000	175.6 1214 T.	.0065 W. .006 F.	NOTE 1
8	G-30	870	.015	-	6.211	9.000	175.6 1389 T.	.007 W. .0065 F.	

**NOTES:**

"W" - wear-land at "edge of work" area  
 "F" - wear-land on flank

1. Chips were approx. 1/2" dia. roll - 12" to 24" long on this part only - yellow and blue color code.

**TABLE 14: DATA FOR LIFE LINES**

<b>Date:</b>	11/4/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228/241 BHN.					
9	G-30	870	.015	-	6.113	9.000	172.8 1562 T.	.008 W. .007 F.	
10	G-30	870	.015	-	6.113	9.000	172.8 1735 T.	.0085 W. .0075 F.	
DATE 11/5/81				PROJECTILE HARDNESS - 228 BHN.					
11	G-30	870	.015	-	6.113	9.000	172.8 1908 T.	.0095 W. .0085 F.	
12	G-30	870	.015	-	6.113	9.000	172.8 2081 T.	.010 W. .009 F.	
				PROJECTILE HARDNESS - 228 BHN.					
13	G-30	870	.015	-	6.092	9.000	172.2 2253 T.	.0105 W. .0095 F.	
14	G-30	870	.015	-	6.092	9.000	172.2 2425 T.	.011 W. .010 F.	
				PROJECTILE HARDNESS - 241 BHN.					
15	G-30	870	.015	-	6.116	9.000	172.9 2598 T.	.0115 W. .0105 F.	
16	G-30	870	.015	-	6.116	9.000	172.9 2771 T.	.0115 W. .0105 F.	

NOTES:

TABLE 15: DATA FOR LIFE LINES



<b>Date:</b>	11/6/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228 BHN.					
1	G-30	830	.022	-	6.112	9.000	172.8	.0035 W. .002 F.	
2	G-30	830	.022	-	6.112	9.000	172.8 346 T.	.004 W. .0025 F.	
				PROJECTILE HARDNESS - 269/286 BHN.					
3	G-30	830	.022	-	6.126	9.000	173.2 519 T.	.0045 W. .003 F.	
4	G-30	830	.022	-	6.126	9.000	173.2 692 T.	.0045 W. .0035 F.	
				PROJECTILE HARDNESS - 241 BHN.					
5	G-30	830	.022	-	6.116	9.000	172.9 865 T.	.005 W. .004 F.	
6	G-30	830	.022	-	6.116	9.000	172.9 1038 T.	.0055 W. .004 F.	
				PROJECTILE HARDNESS - 228 BHN.					
7	G-30	830	.022	-	6.120	9.000	173 1211 T.	.0065 W. .005 F.	
8	G-30	830	.022	-	6.120	9.000	173 1384 T.	.007 W. .0055 F.	

**NOTES:**

"W" - wear-land at "edge of work" area.  
"F" - wear-land on flank.

**TABLE 17: DATA FOR LIFE LINES**

<b>Date:</b> 11/6/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .100"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 269				286 BHN.	
9	G-30	830	.022	-	6.110	9.000	172.7 1557 T.	.0075 W. .006 F.	
10	G-30	830	.022	-	6.110	9.000	172.7 1730 T.	.0085 W. .007 F.	NOTE 1
				PROJECTILE HARDNESS - 269				BHN.	
11	G-30	830	.022	-	6.113	9.000	172.8 1902 T.	.009 W. .0075 F.	NOTE 2
12	G-30	830	.022	-	6.113	9.000	172.8 2076 T.	.0095 W. .008 F.	NOTE 2
				PROJECTILE HARDNESS - 228				BHN.	
13	G-30	830	.022	-	6.127	9.000	173.2 W. 2249 F.	.0105 W. .0085 F.	NOTE 2
14	G-30	830	.022	-	6.127	5.500	105.8 2355 T.	-	NOTE 3

**NOTES:**

- "Chip" on chamfer - outside of "edge of work" area.
- "Chip" did not enlarge.
- Abrupt increase in tang. and feed loads - test stopped - "chip" in flank enlarged and complete failure eminent.

**TABLE 18: DATA FOR LIFE LINES**

<b>Date:</b> 11/6/81	<b>Material:</b> 1340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228			BHN.		
1	G-30	830	.022	-	6.127	3.500	67.4	-	
				PROJECTILE HARDNESS - 241			255 BHN.		
2	G-30	830	.022	-	6.079	9.000	171.8 239 T.	.003 W. .0015 F.	
3	G-30	830	.022	-	6.079	9.000	171.8 411 T.	.0035 W. .002 F.	
				PROJECTILE HARDNESS - 241			255 BHN.		
4	G-30	830	.022	-	6.131	9.000	173.3 584 T.	.004 W. .002 F.	
5	G-30	830	.022	-	6.131	9.000	173.3 757 T.	.0045 W. .003 F.	
				PROJECTILE HARDNESS - 228			241 BHN.		
6	G-30	830	.022	-	6.097	9.000	172.4 929 T.	.005 W. .004 F.	
7	G-30	830	.022	-	6.097	9.000	172.4 1101 T.	.0055 W. .0045 F.	

**NOTES:**  
 "W" - wear-land at "edge of work" area.  
 "F" - wear-land at flank.

**TABLE 19: DATA FOR LIFE LINES**



<b>Date:</b> 11/9/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .100"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228		BHN.			
8	G-30	830	.022	-	6.061	9.000	171.4 1272 T.	.006 W. .005 F.	
9	G-30	830	.022	-	6.061	9.000	171.4 1443 T.	.0065 W. .0055 F.	
				PROJECTILE HARDNESS - 228		BHN.			
10	G-30	830	.022	-	6.058	9.000	171.3 1614 T.	.0075 W. .006 F.	NOTE 1
11	G-30	830	.022	-	6.058	9.000	171.3 1785 T.	.008 W. .0065 F.	
				PROJECTILE HARDNESS - 241		BHN.			
12	G-30	830	.022	-	6.128	4.000	77 1862 T.		NOTE 2

**NOTES:**

1. Small "nick" in chamfer at "edge of work" area.
2. Failure at junction of nose radius and rear clearance angle - increase showed on load charts.

**TABLE 20: DATA FOR LIFE LINES**

<b>Date:</b> 11/9/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241		BHN.			
1	G-10	1000	.015	-	6.128	9.000	173.3	.000 .000	
				PROJECTILE HARDNESS - 241		BHN.			
2	G-10	1000	.015	-	6.121	18.000	346.1 519 T.	.0065 .0045	W. F.
				PROJECTILE HARDNESS - 241		/255 BHN.			
3	G-10	1000	.015	-	6.088	18.000	344.3 863 T.	.007 .0055	W. F.
				PROJECTILE HARDNESS - 228		/241 BHN.			
4	G-10	1000	.015	-	6.122	18.000	346 1209 T.	.0075 .006	W. F.
				PROJECTILE HARDNESS - 255		BHN.			
5	G-10	1000	.015	-	6.100	18.000	345 1554 T.	.0085 .007	W. NOTE 1
				PROJECTILE HARDNESS - 228		/241 BHN.			
6	G-10	1000	.015	-	6.108	18.000	345 1899 T.	.009 .008	W. F.

**NOTES:**

"W" - Wear-land at "edge of work" area

"F" - Wear-land on flank

1. Chip in chamfer in cutting flank area

**TABLE 21: DATA FOR LIFE LINES**

<b>Date:</b>	11/17/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 241 BHN.					
7	G-10	1000	.015	-	6.150	18.000	348 2248 T.	.009 .009	W. F. NOTE 1
				PROJECTILE HARDNESS - 217/228 BHN.					
8	G-10	1000	.015	-	6.145	18.000	347 2595 T.	.0095 .0095	W. F. NOTE 1
				PROJECTILE HARDNESS - 217/228 BHN.					
9	G-10	1000	.015	-	6.125	5.800	111.6 2706 T.	.0095 .0095	W. F. NOTE 2

- NOTES:**
1. Maximum wear-land in flank is at place where "nick" was in Run #5.
  2. Dynamometer showed in increases and decreases in vertical and feed load charts - test stopped - insert had cracks from "nick" down front clearance flank and from "nick" to rear of nose radius.

**TABLE 22: DATA FOR LIFE LINES**



<b>Date:</b> 11/17/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .100"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 228 BHN.					
1	G-10	970	.022	-	6.154	9.900	191	-	
				PROJECTILE HARDNESS - 228/241 BHN					
2	G-10	970	.022	-	6.134	7.200	139 330 T	-	NOTE 1
				NEW INSERT					
				PROJECTILE HARDNESS - 228/241 BHN					
1	G-10	970	.022	-	6.134	9.200	177.3	.004 W. .000 F.	
				PROJECTILE HARDNESS - 217/228 BHN					
2	G-10	970	.022	-	6.127	17.000	327.2 505 T	.0045 W. .003 F.	
				PROJECTILE HARDNESS - 207/217 BHN					
3	G-10	970	.022	-	6.154	5.600	108.3 613 T	-	NOTE 2

**NOTES:**

1. Load charts showed drop in loads for short distance - then increase test stopped - insert had crack from cutting edge to bottom of insert.
2. Insert chipped out in "edge of work" area - load changes noted with dynamometer.

**TABLE 24: DATA FOR LIFE LINES**

**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 1340

**HARDNESS:** 228/24L BHN.

**INSERT:** TNMG-433

**SURFACE FEED:** 630

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

FT./MIN.

**GRADE:** 570

**FEEDRATE:** .025 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	380	130	180
.100	740	280	230
.150	1120	420	300
.200	1480	600	360

**INSERT:** CNG-454  
820

**SURFACE FEED:** 870

**COOLANT:** NONE

FT./MIN.

**GRADE:** G-30

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	260	110	150
.100	520	260	180
.150	760	380	220
.200	1000	520	250

**INSERT:**

**SURFACE FEED:**

**COOLANT:**

**GRADE:**

**FEEDRATE:**

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD

**TABLE 25: DATA FOR TOO LOAD CHARTS**



## TOOL LOAD VERSUS DEPTH OF CUT

Material: 1340

Holder: CTANR-164

Hardness: 228/241 BHN.

Insert: TNMG-433-E48

Feed Rate: .025 IN./REV.

Grade: 570

Surface Speed: 630 FT./MIN.

Coolant: TRIM-SOL 20:1 TOP

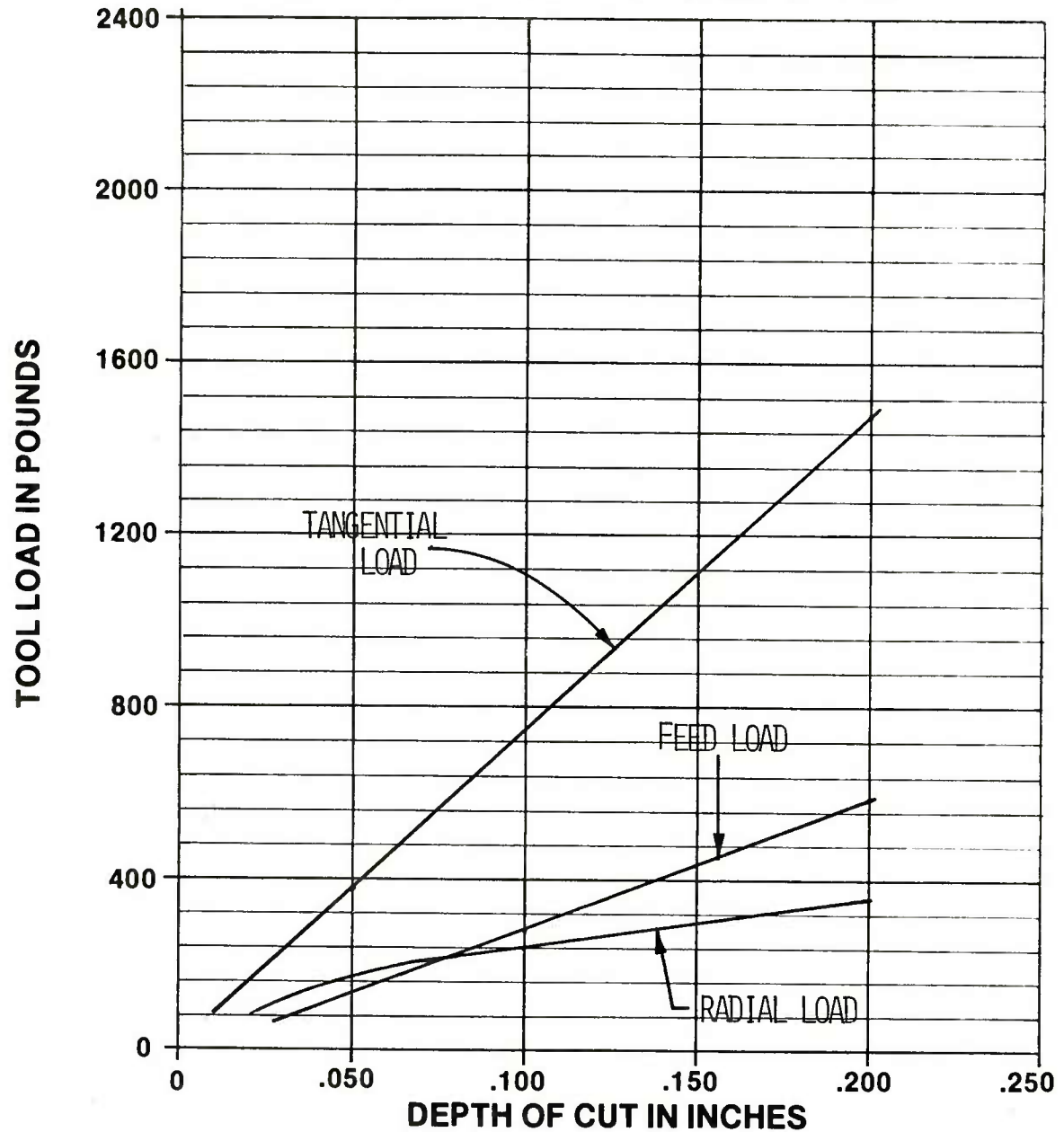


FIGURE 38: TOOL LOAD CHART

## TOOL LOAD VERSUS DEPTH OF CUT

Material: 1340

Holder: CCGNR-164  
0° LEAD ANGLE

Hardness: 228/241 BHN.

Insert: CNG-454-820

Feed Rate: .015 IN./REV.

Grade: G-30

Surface Speed: 870 FT./MIN.

Coolant: NONE

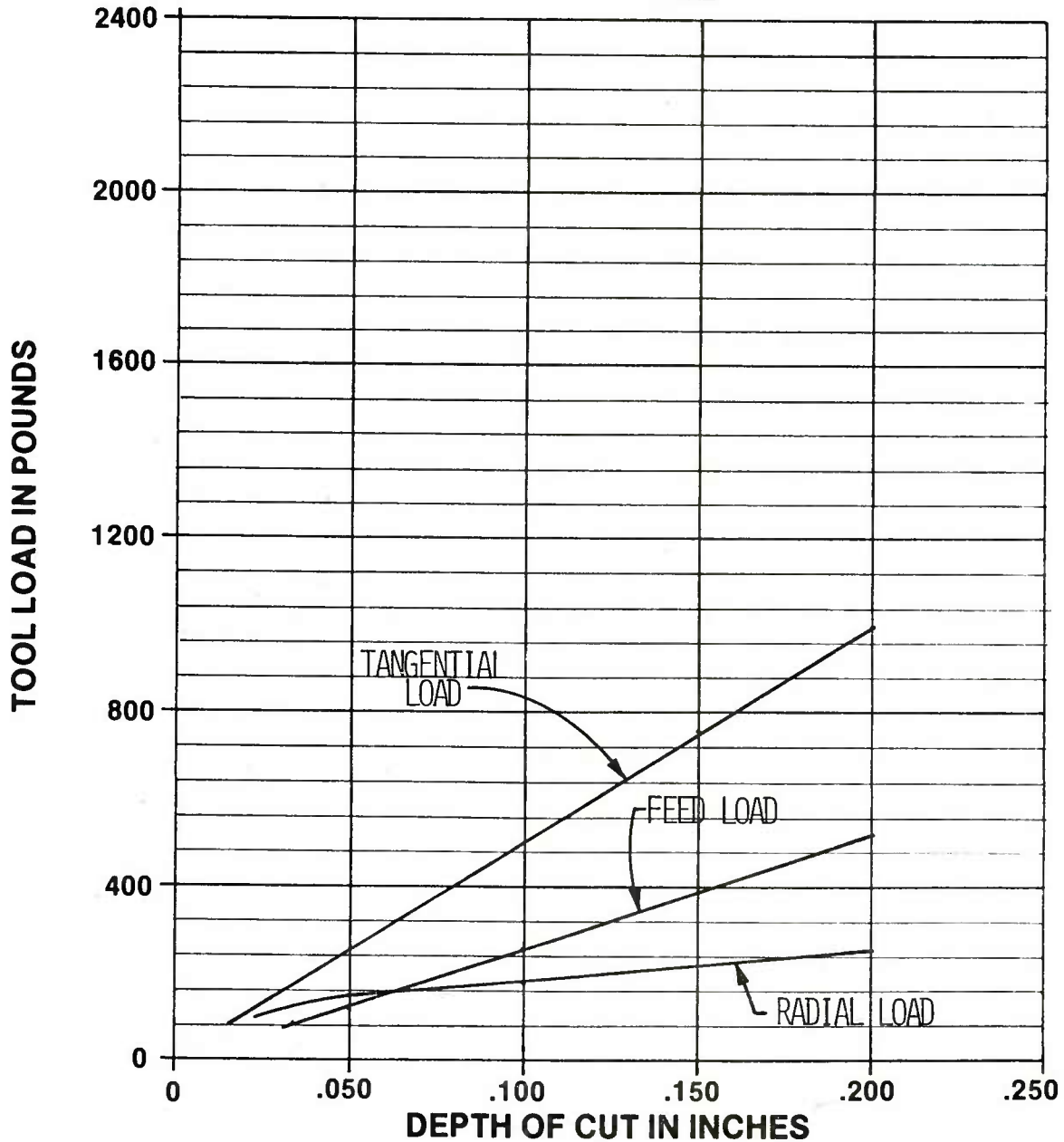


FIGURE 39: TOOL LOAD CHART

<b>Date:</b> 12/30/81 <b>Depth of Cut:</b> APPROX. .050" <b>Hardness:</b> SEE FIGURE <b>Coolant Application:</b>	<b>Material:</b> 1340 <b>Coolant:</b> <b>Tool Description:</b> <b>Holder:</b> SEE FIGURE <b>Insert:</b> SEE FIGURE
---	--

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				LIFE-LINE DATA FROM TEST					
1	570	440	.015	-	-	-	3100	.018	3100   .018
2	570	480	.015	-	-	-	2500	.018	2500   .018
				LIFE-LINE DATA FROM PREVIOUS TEST					
3	570	500	.015	-	-	-	327	.0065	905   .018
4	570	700	.015	-	-	-	55.4	.011	90   .018
5	570	600	.015	-	-	-	269	.0085	570   .018
				LIFE-LINE DATA FROM TEST					
1	G-30	660	.015	-	-	-	3000	.015	3000   .015
2	G-30	725	.015	-	-	-	2700	.015	2700   .015
				LIFE-LINE DATA FROM PREVIOUS TEST					
3	G-30	900	.015	-	-	-	207	.004	776   .015
4	G-30	1000	.015	-	-	-	173	.005	519   .015

**NOTES:**

**TABLE 26: DATA FOR LIFE LINES**

<b>Date:</b> <u>12/30/81</u>	<b>Material:</b> <u>1340</u>
<b>Depth of Cut:</b> <u>APPROX. - .050"</u>	<b>Coolant:</b> _____
<b>Hardness:</b> <u>SEE FIGURE</u>	<b>Tool Description:</b> _____
<b>Coolant Application:</b> _____	<b>Holder:</b> <u>SEE FIGURE</u>
	<b>Insert:</b> <u>SEE FIGURE</u>

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
5	G-30	800	.015	-	-	-	290	.004	1088 .015
				LIFE-LINE DATA FROM TEST					
1	G-10	660	.015	-	-	-	2600	.015	
				LIFE-LINE DATA FROM PREVIOUS TESTS					
2	G-10	800	.015	-	-	-	404	.0055	1103 .015
3	G-10	900	.015	-	-	-	208	.0045	695 .015
4	G-10	1000	.015	-	-	-	95	.003	434 .015

**NOTES:**

**TABLE 27: DATA FOR LIFE LINES**

<b>Date:</b>	12/7/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 302				311 BHN.	
1	570	480	.015	-	6.050	8.900	169	.0055	NOTE 1
2	570	480	.015	-	6.050	9.000	171 340 T.	.0065	
				PROJECTILE HARDNESS - 321				340 BHN.	
3	570	480	.015	-	6.030	17.800	337 677 T.	.0075	
				PROJECTILE HARDNESS - 340				BHN.	
4	570	480	.015	-	6.008	16.500	311.4 988 T.	.0085	NOTE 2
				PROJECTILE HARDNESS - 340				BHN.	
5	570	480	.015	-	6.002	17.800	335.6 1324 T.	.0095	
	DATE	12/8/81		PROJECTILE HARDNESS - 351				BHN.	
6	570	480	.015	-	6.025	17.800	336.9 1661 T.	.011	
				PROJECTILE HARDNESS - 340				BHN.	
7	570	480	.015	-	6.018	17.900	338.4 1999 T.	.0135	

**NOTES:**

1. Chip condition 1/2" diameter roll - 8" to 12" long.
2. Chip condition 1/2" diameter roll - 3" to 6" long.  
Did not finish turn - excessive runout.

**TABLE 28: DATA FOR LIFE LINES**

<b>Date:</b>	12/8/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 321 BHN.					
8	570	480	.015	-	6.116	17.900	343.9 2343 T.	.016	
				PROJECTILE HARDNESS - 340 BHN.					
9	570	480	.015	-	6.037	8.900	168.8 2512 T.	.0175	
10	570	480	.015	-	6.037	9.000	170.7 2683 T.	.020	
				PROJECTILE HARDNESS - 302/311 BHN.					
11	570	480	.015	-	6.055	8.900	169.3 2852 T.	.0225	NOTE 1

**NOTES:**  
 1. Chip condition - continuous string - no control.

**TABLE 29: DATA FOR LIFE LINES**



<b>Date:</b> 12/8/81				<b>Material:</b> 1340					
<b>Depth of Cut:</b> .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 302/311 BHN.					
1	570	440	.015	-	6.055	9.000	171.2	.006	
				PROJECTILE HARDNESS - 340 BHN.					
2	570	440	.015	-	6.009	8.900	168 339 T.	.0065	NOTE 1
3	570	440	.015	-	6.009	9.000	169.9 509 T.	.007	
				PROJECTILE HARDNESS - 340 BHN.					
4	570	440	.015	-	5.980	17.800	334.4 843 T.	.008	
				PROJECTILE HARDNESS - 340 BHN.					
5	570	440	.015	-	6.082	17.800	340.1 1183 T.	.009	
	DATE 12/9/81			PROJECTILE HARDNESS - 340 BHN.					
6	570	440	.015	-	6.033	17.800	337.4 1520 T.	.0095	
				PROJECTILE HARDNESS - 321/340 BHN.					
7	570	440	.015	-	6.075	17.800	339.7 1860 T.	.0105	

**NOTES:**  
1. Chip condition 1/2" diameter roll - 8" to 12" long.

TABLE 30: DATA FOR LIFE LINES

<b>Date:</b>	12/9/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 302/321 BHN.					
8	570	440	.015	-	6.044	17.900	339.9 2200 T.	.0115	
				PROJECTILE HARDNESS - 321 BHN.					
9	570	440	.015	-	6.042	17.500	332.2 2532 T.	.0125	
	DATE	12/10/81		PROJECTILE HARDNESS - 340/364 BHN.					
10	570	440	.015	-	6.042	17.900	339.8 2872 T.	.0155	
				PROJECTILE HARDNESS - 340/364 BHN.					
11	570	440	.015	-	6.027	8.900	168.5 3041 T.	.0185	
12	570	440	.015	-	6.027	9.000	170.4 3211 T.	.0195	
				PROJECTILE HARDNESS - 340 BHN.					
13	570	440	.015	-	6.031	8.800	166.7 3378 T.	.0215	NOTE 1
14	570	440	.015	-	6.031	9.000	170.5 3549 T.	.0235	

**NOTES:**  
 1. Chip condition 3/4" diameter roll - 12" long or more.

**TABLE 31: DATA FOR LIFE LINES**

<b>Date:</b>	12/10/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	.050 inches	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340 BHN.					
1	G-30	660	.015	-	6.004	18.100	341.4	.003	NOTE 1
				PROJECTILE HARDNESS - 321 BHN.					
2	G-30	660	.015	-	6.056	18.000	342.4 684 T.	.005	
				PROJECTILE HARDNESS - 364 BHN.					
3	G-30	660	.015	-	6.025	18.100	342.6 1027 T.	.007	
				PROJECTILE HARDNESS - 340 BHN.					
4	G-30	660	.015	-	6.065	17.900	341 1364 T.	.0085	
	DATE	12/11/81		PROJECTILE HARDNESS - 340 BHN.					
5	G-30	660	.015	-	6.051	17.800	338.3 1702 T.	.010	
				PROJECTILE HARDNESS - 340 BHN.					
6	G-30	660	.015	-	6.968	18.00	337.4 2039 T.	.0115	

**NOTES:**

1. Chip condition - 1/4" diameter roll - 8" to 12" long.

**TABLE 32: DATA FOR LIFE LINES**



<b>Date:</b> 12/11/81		<b>Material:</b> 1340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-630	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE	HARDNESS	- 321/340	BHN.		
1	G-30	725	.015	-	6.015	18.000	340	.004	NOTE 1
				PROJECTILE	HARDNESS	- 321/340	BHN.		
2	G-30	725	.015	-	5.992	18.100	340 T. 681 T.	.006	
				PROJECTILE	HARDNESS	- 321	BHN.		
3	G-30	725	.015	-	5.975	18.100	339.8 1021 T.	.0075	
				PROJECTILE	HARDNESS	- 340	BHN.		
4	G-30	725	.015	-	6.033	18.000	341.1 1362 T.	.0095	
	DATE 12/14/81			PROJECTILE	HARDNESS	- 340	BHN.		
5	G-30	725	.015	-	6.056	18.100	344.4 1706 T.	.011	
				PROJECTILE	HARDNESS	- 321	BHN.		
6	G-30	725	.015	-	6.027	14.900	282 1988 T.	.0125	NOTE 2

**NOTES:**

1. Chip condition same as 660 Ft/Min. (1/4" diameter roll-8" to 10" long)
2. Did not turn full length - excessive runout

**TABLE 34: DATA FOR LIFE LINES**

<b>Date:</b>	12/14/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 321 BHN.		
7	G-30	725	.015	-	6.012	18.000	340 2328 T.	.0135	NOTE 1
							PROJECTILE HARDNESS - 321 BHN.		
8	G-30	725	.015	-	6.037	18.000	341.4 2669 T.	.0145	
							PROJECTILE HARDNESS - 321/340 BHN.		
9	G-30	725	.015	-	5.950	17.700	330.8 3000 T.	.016	NOTE 2
							PROJECTILE HARDNESS - 340 BHN.		
10	G-30	725	.015	-	6.028	17.000	322 3322 T.	.017	NOTE 3

**NOTES:**  
1. Variation in feed and radial loads noted - not related to out-of-foundness - higher frequency.  
2. Variation in tool loads - radial 180 lbs. to 320 lbs. - feed load 200 to 240 lbs. - audible range - visible on work-piece.  
3. Projectile shows annular grooves or bands where load varies - .0005 to .001 deep.

**TABLE 35: DATA FOR LIFE LINES**



<b>Date:</b>	12/16/81	<b>Material:</b>	1340
<b>Depth of Cut:</b>	APPROX .050	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	CNC-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS	— 340 BHN.				
1	G-10	660	.015	—	6.021	17.600	332.9	.004	
				PROJECTILE HARDNESS	— 321/340 BHN.				
2	G-10	660	.015	—	6.049	17.800	338.2 671 T.	.006	
				PROJECTILE HARDNESS	— 321 BHN.				
3	G-10	660	.015	—	6.025	17.800	336.9 1008 T.	.0075	
				PROJECTILE HARDNESS	— 311 BHN.				
4	G-10	660	.015	—	6.030	18.000	340.9 1349 T.	.0095	
				PROJECTILE HARDNESS	— 321 BHN.				
5	G-10	660	.015	—	6.015	18.000	340.1 1689 T.	.011	NOTE 1
				PROJECTILE HARDNESS	— 340 BHN.				
6	G-10	660	.015	—	6.009	17.900	337.9 2027 T.	.0125	

**NOTES:**

1. 100% load variation in radial load, 200 lbs. to 300 lbs. - visible on work-piece as "waves" - 1/2" cycle.

**TABLE 36: DATA FOR LIFE LINES**

**Date:** 12/17/81

**Material:** 1340

**Depth of Cut:** APPROX. .050"

**Coolant:** TRIM-SOL 20:1

**Hardness:** SEE TAB

**Tool Description:** \_\_\_\_\_

**Coolant Application:** TOP

**Holder:** CCGNR-164

**Insert:** CNG-454-630

[illegible]

**NOTES:**

1. Some "banding" - but not as bad as Run #6.
2. "Banding" worse than Run #6 - 1st 2" of turn was good, but rest had "banding".

**TABLE 37: DATA FOR LIFE LINES**

<b>Date:</b> 12/17/81				<b>Material:</b> 1340					
<b>Depth of Cut:</b> APPROX. .050				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 321 BHN.					
1	G-10	660	.015	-	6.014	17.500	330.6	.003	
				PROJECTILE HARDNESS - 321 BHN.					
2	G-10	660	.015	-	6.002	18.000	339.4 670 T.	.0045	
				PROJECTILE HARDNESS - 302 BHN.					
3	G-10	660	.015	-	5.989	18.300	344.3 1014 T.	.0065	
				PROJECTILE HARDNESS - 321 BHN.					
4	G-10	660	.015	-	6.026	17.600	333.2 1347 T.	.008	
				PROJECTILE HARDNESS - 340 BHN.					
5	G-10	660	.015	-	6.058	17.600	334.9 1682 T.	.009	
				PROJECTILE HARDNESS - 321 BHN.					
6	G-10	660	.015	-	6.016	17.800	336.4 2018 T.	.0105	NOTE 1

**NOTES:**  
1. Some "banding" on work-piece - variations in radial load seen on recorder.

TABLE 38: DATA FOR LIFE LINES



**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF  
CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS  
OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 1340

**HARDNESS:** 340 BHN.

**INSERT:** TNMG-433  
E-48

**SURFACE FEED:** 460  
FT./MIN.

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** 570

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	140	60	140
.050	280	160	200
.100	540	330	230
.150	780	480	270

**INSERT:** CNG-454  
630

**SURFACE FEED:** 680

**COOLANT:** NONE

**GRADE:** G-30

**FEEDRATE:** .015

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	160	60	130
.050	300	140	180
.100	580	320	220
.150	840	500	260

**INSERT:** CNG-454  
820

**SURFACE FEED:** 660

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** G-10

**FEEDRATE:** .015

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	150	50	100
.050	280	120	160
.100	560	300	200
.150	840	480	240

**TABLE 40: DATA FOR TOOL LOAD CHARTS**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 1340

**HOLDER:** CTANR-164

**HARDNESS:** 340 BHN.

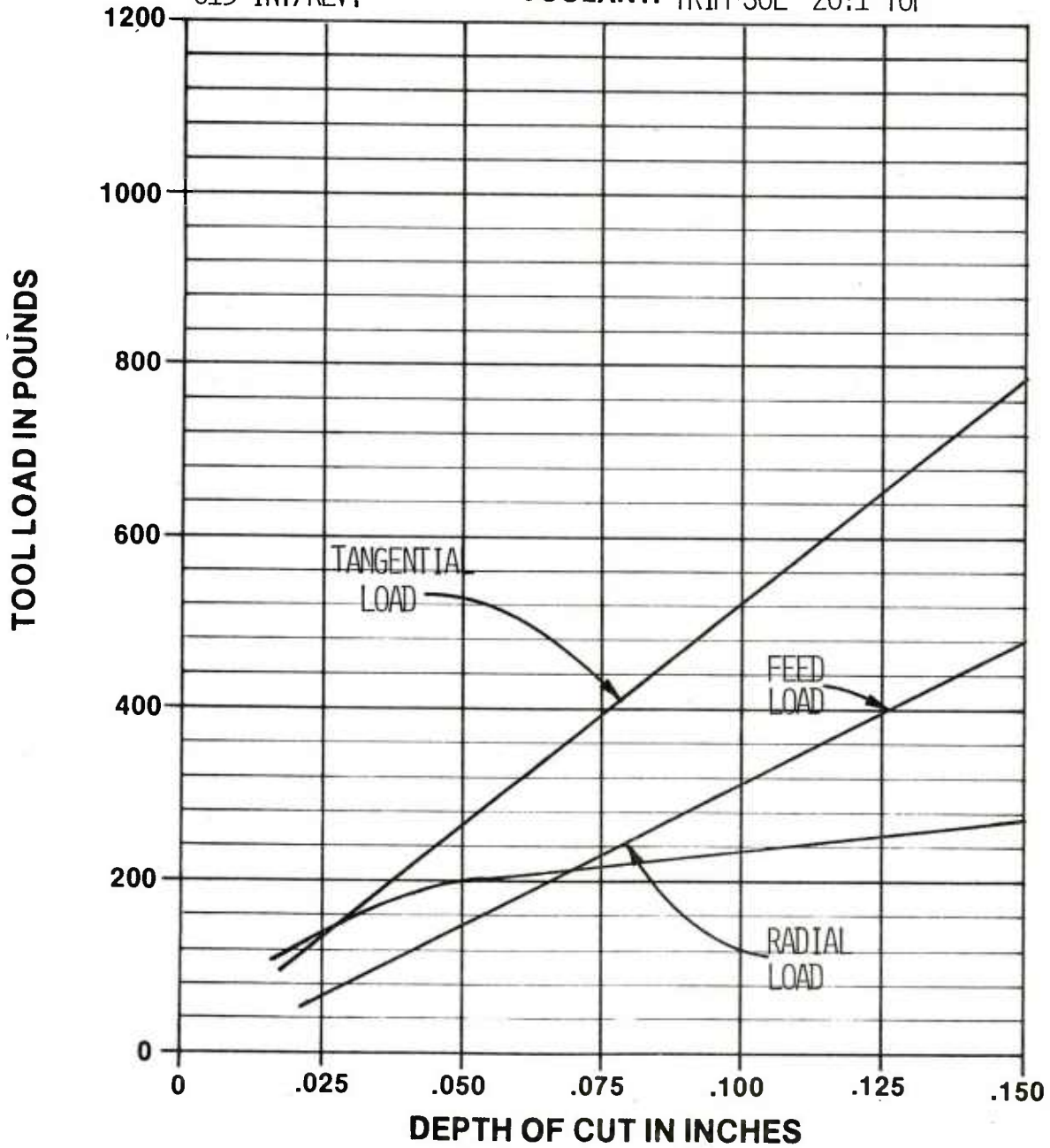
**INSERT:** TNMG-433E48

**SURFACE SPEED:** 460 FT./MIN.

**GRADE:** 570

**FEED RATE:** 0.015 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 40: TOOL LOAD CHART**



### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 1340

**HOLDER:** CCGNR-164

**HARDNESS:** 340 BHN.

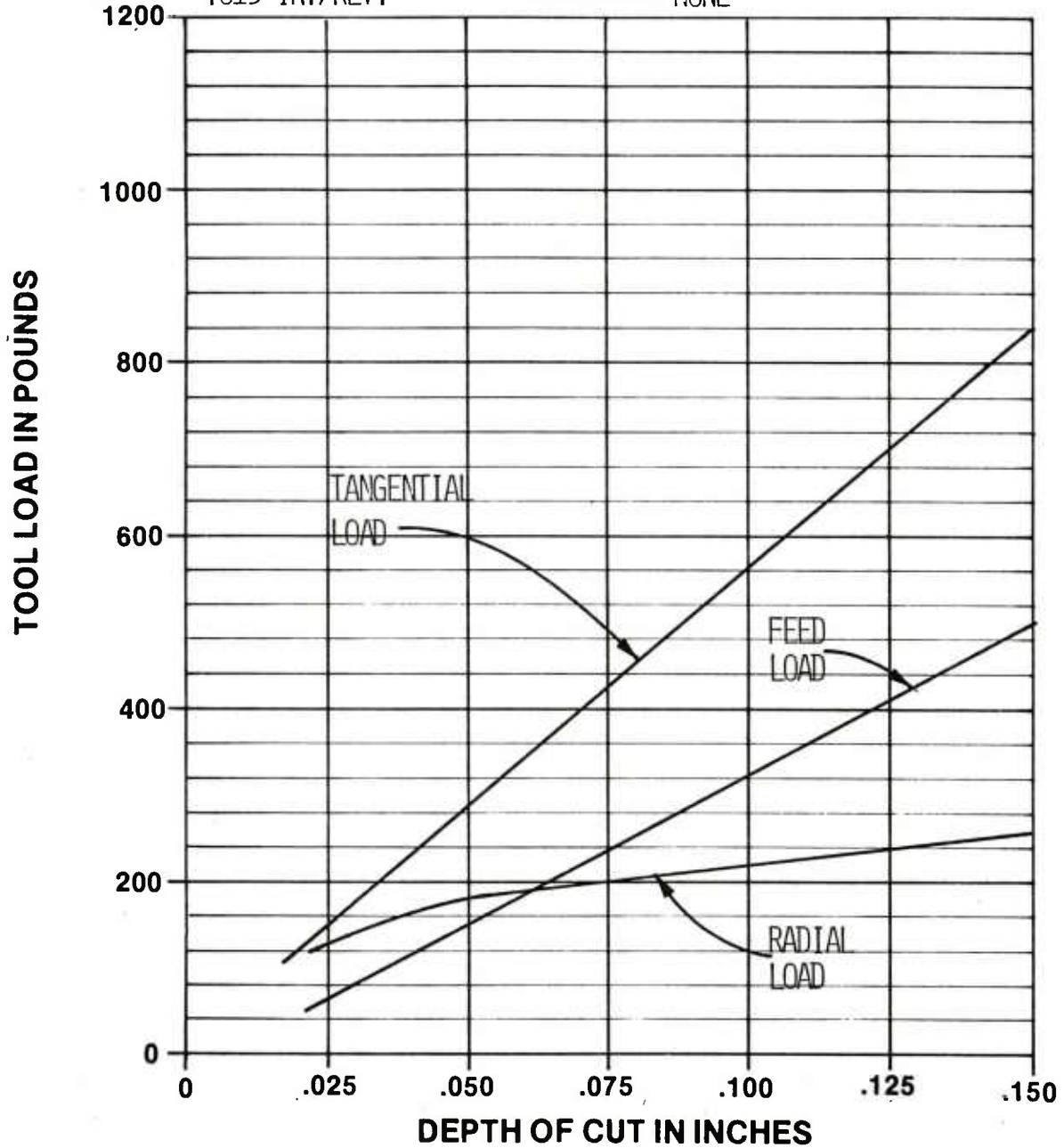
**INSERT:** CNG-454-630

**SURFACE SPEED:** 680 FT./MIN.

**GRADE:** G-30

**FEED RATE:** .015 IN./REV.

**COOLANT:** NONE



**FIGURE 41: TOOL LOAD CHART**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 1340

**HOLDER:** CCGNR-164

**HARDNESS:** 340 BHN.

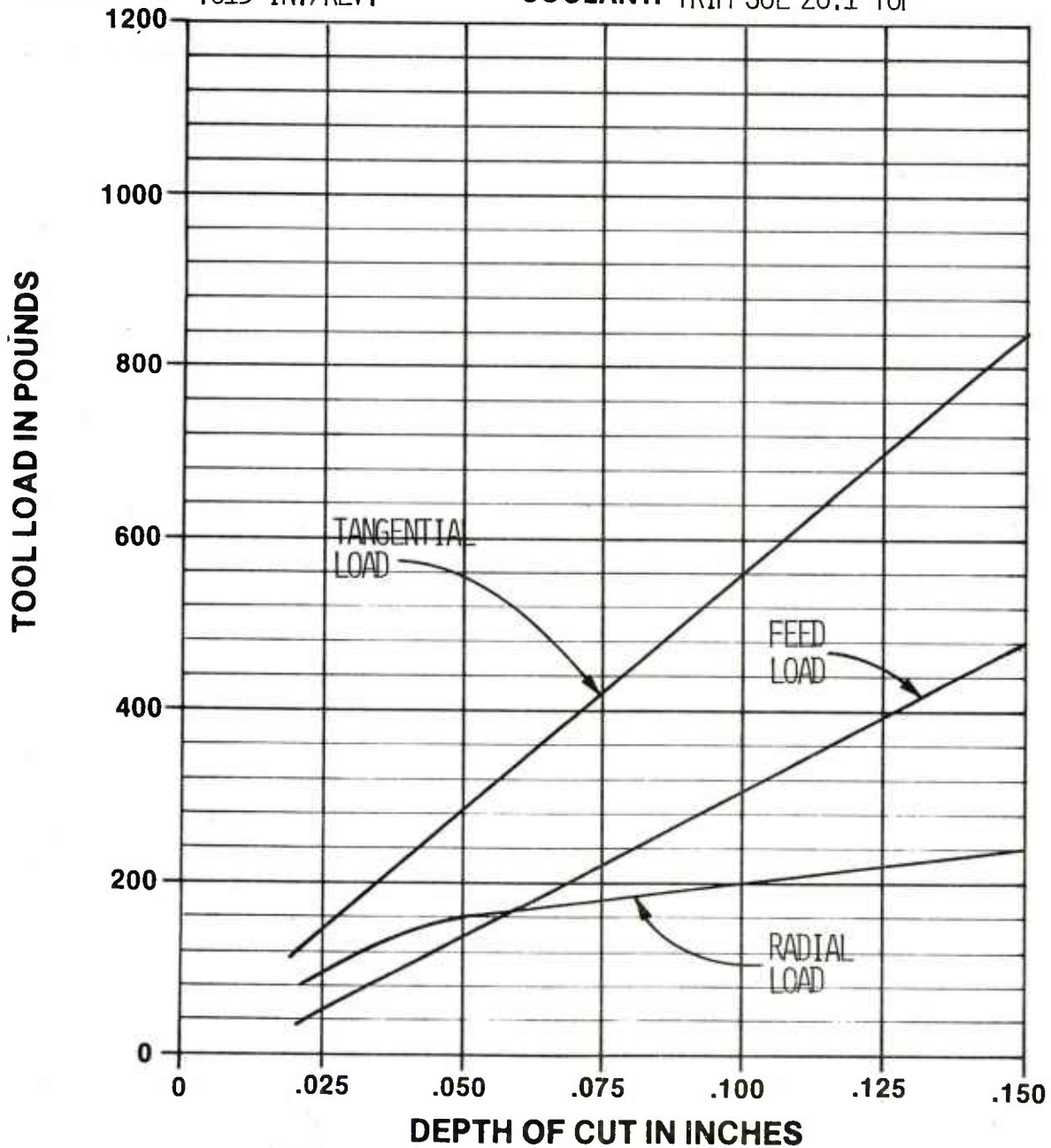
**INSERT:** CNG-454-820

**SURFACE SPEED:** 680 FT./MIN.

**GRADE:** G-10

**FEED RATE:** .015 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 42: TOOL LOAD CHART**

<b>Date:</b>	9/22/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	-
<b>Hardness:</b>	SEE CHART	<b>Tool Description:</b>	
<b>Coolant Application:</b>	-	<b>Holder:</b>	-
		<b>Insert:</b>	-

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
	570	800	.025	-	-	-	305	.0095	481   .015
	570	1000	.025	-	-	-	152.5	.012	190   .015
	570	500	.025	(FROM CONFIRMATION TESTS)					3500   .015
	G-30	1100	.015	-	-	-	459	.023	300   .015
	G-30	1000	.015	-	-	-	611	.017	540   .015
	G-30	850	.015	(FROM CONFIRMATION TESTS)					2000   .015

**NOTES:**

**TABLE 41: DATA FOR LIFE LINES**

<b>Date:</b> 9/8/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 207 BHN.					
1	570	360	.033	-	8.155	6"	153.7	.0045	NOTE 1
2	570	360	.033	-	8.155	6"	153.7 307 T.	.006	NOTE 2
3	570	360	.033	-	8.155	12"	307.4 615 T.	.012	
				NEW PROJECTILE HARDNESS - 196/207 BHN.					
4	570	360	.033	-	8.145	12"	307.1 922 T.	.0125	
5	570	360	.033	-	8.145	12"	307.1 1229 T.	.0135	
				NEW PROJECTILE HARDNESS 192/207 BHN.					
6	570	360	.033	-	8.125	12"	306.3 1535 T.	.014	
7	570	360	.033	-	8.125	12"	306.3 1842 T.	.0145	
				NEW PROJECTILE HARDNESS 179/187 BHN.					
8	570	360	.033	-	8.155	12"	307.4 2149 T.	.015	
9	570	360	.033	-	8.155	12"	307.4 2456 T.	.0155	

**NOTES:**  
NOTE 1: Chips-.250 inch diameter curl-short to 2 inch length  
NOTE 2: Slight build-up in nose radius

**TABLE 42: DATA FOR LIFE LINES**

<b>Date:</b> 9/8/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				NEW PROJECTILE HARDNESS - 196 BHN.					
10	570	360	.033	-	8.165	12"	307.8 2764 T.	.016	
11	570	360	.033	-	8.165	12"	307.8 3072 T.	.0165	
				DATE 9/9/81 - NEW PROJECTILE HARDNESS - 179 BHN.					
12	570	360	.033	-	8.145	12"	307.1 379 T.	.018	
13	570	360	.033	-	8.145	12"	307.1 3686 T.	.0185	
				NEW PROJECTILE HARDNESS 196/207 BHN.					
14	570	360	.033	-	8.140	12"	306.9 3993 T.	.019	
15	570	360	.033	-	8.140	12"	306.9 4300 T.	.019	
				NEW PROJECTILE HARDNESS 179 BHN.					
16	570	360	.033	-	8.190	12"	308.8 4609 T.	.019	
17	570	360	.033	-	8.190	-	-	-	NOTE 1

**NOTES:**  
NOTE 1: Part turned in chuck jaws at start of cut - tool broke.

**TABLE 43: DATA FOR LIFE LINES**

<b>Date:</b> 9/9/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 187/202 BHN.					
1	570	400	.033	-	8.125	6	153.2	.0035	NOTE 1
2	570	400	.033	-	8.125	6	153.2 306 T.	.006	
3	570	400	.033	-	8.125	6	153.2 460 T.	.008	
4	570	400	.033	-	8.125	6	153.2 613 T.	.009	
				NEW PROJECTILE HARDNESS 187/196 BHN.					
5	570	400	.033	-	8.170	12	308 921 T.	.010	NOTE 2
6	570	400	.033	-	8.170	12	308 1229 T.	.0105	
				NEW PROJECTILE HARDNESS - 196 BHN.					
7	570	400	.033	-	8.115	12	305.9 1535 T.	.0105	
8	570	400	.033	-	8.115	12	305.9 1841 T.	.011	

**NOTES:**  
NOTE 1: Chip condition - short segmented chips  
  
NOTE 2: Bad out-of-round condition

**TABLE 44: DATA FOR LIFE LINES**





<b>Date:</b> 9/10/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
			NEW PROJECTILE HARDNESS - 196				BHN.		
1	570	500	.033	-	8.175	6	154.1	.0075	
2	570	500	.033	-	8.175	6	154.1 308 T.	.0085	
3	570	500	.033	-	8.175	6	154.1 462 T.	.010	
4	570	500	.033	-	8.175	6	154.1 616 T.	.0105	
			NEW PROJECTILE HARDNESS - 196				207 BHN.		
5	570	500	.033	-	8.115	12	305.9 922 T.	.011	
6	570	500	.033	-	8.115	12	305.9 1228 T.	.012	NOTE 1
			NEW PROJECTILE HARDNESS 187/196				BHN.		
7	570	500	.033	-	8.115	12	307.4 1535 T.	.013	NOTE 2
8	570	500	.033	-	8.115	2.5	64 1600 T.	-	NOTE 3

**NOTES:**

NOTE 1: Slight chip in leading edge of tool - 1/4" from nose radius - well behind cutting area.

NOTE 2: Chip in edge larger-.180" from nose radius .040" wide.

NOTE 3: Tool broke in "nick" area.

**TABLE 46: DATA FOR LIFE LINES**

<b>Date:</b> 9/11/81				<b>Material:</b> 4140			
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 196 BHN.					
1	570	950	.033	-	8.160	2"	51.3	.0075	136 .020
2	570	850	.033	-	8.160	4-3/4"	121.8	.008	304 .020
1	570	600	.033	-	8.160	5.25	134.6	.0065	
2	570	600	.033	-	8.160	6	153.8 288 T.	.0085	
3	570	600	.033	-	8.160	6	153.8 442 T.	.009	
				PROJECTILE HARDNESS 196 BHN.					
4	570	600	.033	-	8.180	12	308.4 750 T.	.0095	
5	570	600	.033	-	8.180	12	308.4 1058 T.	.010	
				PROJECTILE HARDNESS 196/207 BHN.					
6	570	600	.033	-	8.158	12	307.5 1366 T.	.011*	
7	570	600	.033	-	8.158	12	307.5 1674 T.	.012*	

NOTES:

\* Nose Wear

TABLE 47: DATA FOR LIFE LINES

<b>Date:</b>	9/11/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 179/187 BHN.					
8	570	600	.033	-	8.120	12	306.1 1980 T.	.0155*	
9	570	600	.033	-	8.120	12	306.1 2286 T.	.017*	
				PROJECTILE HARDNESS 187 BHN.					
10	570	600	.033	-	8.118	12	306 2592 T.	.0175*	
11	570	600	.033	-	8.118	12	306 2898 T.	.0185*	
				PROJECTILE HARDNESS 179/187 BHN.					
12	570	600	.033	-	8.123	12	306.2 3204 T.	.020*	
13	570	600	.033	-	8.123	12	306.2 3510 T.	.0215	
				PROJECTILE HARDNESS 187/196 BHN.					
14	570	600	.033	-	8.126	12	306.3 3816 T.	.0225	
15	570	600	.033	-	8.126	12	306.3 4122 T.	.024	

**NOTES:**

\* NOSE WEAR

**TABLE 48: DATA FOR LIFE LINES**

<b>Date:</b>	9/14/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 196 BHN.					
1	570	600	.033	-	8.138	6"	153.4	.0065	
2	570	600	.033	-	8.138	6"	153.4 307 T.	.0085	
3	570	600	.033	-	8.138	6"	153.4 460 T.	.0095	
4	570	600	.033	-	8.138	6"	153.4 614 T.	.010	NOTE 1
				PROJECTILE HARDNESS - 196 BHN.					
5	570	600	.033	-	8.155	12"	307.4 921 T.	.0105	NOTE 1
6	570	600	.033	-	8.155	12"	307.4 1229 T.	.0115	
				PROJECTILE HARDNESS - 187 BHN.					
7	570	600	.033	-	8.170	12"	308 1537 T.	.012*	
8	570	600	.033	-	8.170	3"	TOOL BROKE - NOTE 2		

**NOTES:** \* NOSE WEAR

NOTE 1: Flank and nose wear land equal.

NOTE 2: There was no indication from the dynamometer that the insert would break - shell examined and no visible evidence on the outside of shell to cause breakage - no excessive runout.

**TABLE 49: DATA FOR LIFE LINES**

<b>Date:</b> 9/14/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 187/196 BHN.					
1	570	600	.033	-	8.122	6	153.1	.010*	
2	570	600	.033	-	8.122	6	153.1 306 T.	.011*	NOTE 1
				NEW INSERT					
1	570	600	.033	-	8.122	6	153.1	.0065	
2	570	600	.033	-	8.122	6	153.1 306 T.	.008	
				PROJECTILE HARDNESS 187/196 BHN.					
3	570	600	.033	-	8.135	12	306 612 T.	.0095	
4	570	600	.033	-	8.135	3	76.7 689 T.	TOOL BROKE NOTE 2	

**NOTES:**    \* NOSE WEAR  
  
NOTE 1:    Insert had uneven wear on nose radius, and only .005 flank wear - test stopped.  
  
NOTE 2:    Insert broke - no indication from dynamometer or visible signs on projectile.

**TABLE 50: DATA FOR LIFE LINES**



<b>Date:</b> 9/15/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E-68	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 179/187 BHN.					
1	570	500	.033	-	8.137	6	153.4 F. 307 T.	.0055	
2	570	500	.033	-	8.137	6	153.4 F. 460 T.	.007	
3	570	500	.033	-	8.137	6	153.4 F. 614 T.	.0085	
4	570	500	.033	-	8.137	6	153.4 F. 614 T.	.009	
				PROJECTILE HARDNESS 170/179 BHN.					
5	570	500	.033	-	8.122	12	306.2 F. 920 T.	.0095	
6	570	500	.033	-	8.122	3	TOOL BROKE NOTE 1		

**NOTES:**  
 NOTE 1: Tool broke with no indication from dynamometer or visible signs on projectile.

TABLE 51: DATA FOR LIFE LINES

<b>Date:</b> 9/15/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E-68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 170/179 BHN.					
1	570	500	.025	-	8.122	8.5	217	.008 <sup>F</sup>	
				PROJECTILE HARDNESS 186/196 BHN.					
2	570	500	.025	-	8.119	12	306 523 T.	.010 <sup>F</sup>	
3	570	500	.025	-	8.119	12	306 829 T.	.0105 <sup>F</sup>	
				PROJECTILE HARDNESS - 196 BHN.					
4	570	500	.025	-	8.135	12	306.7 1136 T.	.011 <sup>F</sup>	
5	570	500	.025	-	8.135	12	306.7 1442 T.	.011 <sup>F</sup>	
				PROJECTILE HARDNESS 187/196 BHN.					
6	570	500	.025	-	8.192	12	308.8 1751 T.	.0115 <sup>F</sup>	
7	570	500	.025	-	8.192	12	308.8 2060 T.	.012 <sup>F</sup>	

**NOTES:**

**TABLE 52: DATA FOR LIFE LINES**

<b>Date:</b> 9/15/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E-68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 196/207 BHN.					
8	570	500	.025	-	8.149	12	2367 T.	.012	
9	570	500	.025	-	8.149	12	307.2 F. 2367 T.	.0125	
				PROJECTILE HARDNESS 179/187 BHN.					
10	570	500	.025	-	8.130	12	306.5 F. 2980 T.	.0125	
11	570	500	.025	-	8.130	12	306.5 F. 3287 T.	.0125	
				PROJECTILE HARDNESS - 187/196 BHN.					
12	570	500	.025	-	8.181	12	308.4 F. 3595 T.	.013	
13	570	500	.025	-	8.181	12	308.4 F. 3903 T.	.013	

**NOTES:**

**TABLE 53: DATA FOR LIFE LINES**

<b>Date:</b> 9/16/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E-68	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 217 BHN.					
1	570	500	.025	-	8.107	6	152.8 <sup>F</sup> 306 T	.0065	
2	570	500	.025	-	8.107	6	152.8 <sup>F</sup> 458 T	.007	
3	570	500	.025	-	8.107	6	152.8 <sup>F</sup> 611 T	.007	
4	570	500	.025	-	8.107	6	152.8 <sup>F</sup> 916 T	.0085	
				PROJECTILE HARDNESS 179/187 BHN.					
5	570	500	.025	-	8.082	12	304.7 <sup>F</sup> 1220 T	.009	
6	570	500	.025	-	8.082	12	304.7 <sup>N</sup> 1835 T	.009	
				PROJECTILE HARDNESS 187/196 BHN.					
7	570	500	.025	-	8.160	12	307.6 <sup>F</sup> 1528 T	.011	
8	570	500	.025	-	8.160	12	307.6 <sup>F</sup> 1835 T	.012	

**NOTES:**

TABLE 54: DATA FOR LIFE LINES

<b>Date:</b>	9/16/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E-68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 187/196 BHN.					
9	570	500	.025	-	8.150	12	307.2 2142 T	F. .0135	
10	570	500	.025	-	8.150	12	307.2 2450 T	F. .014	
				PROJECTILE HARDNESS 179 BHN.					
11	570	500	.025	-	8.092	12	305 2755 T	F. .015	
12	570	500	.025	-	8.092	12	305 3060 T	N. .015	
				PROJECTILE HARDNESS 187/196 BHN.					
13	570	500	.025	-	8.142	12	306.9 3367 T	N. .0155	
14	570	500	.025	-	8.142	12	306.9 3674 T	F. .016	
				PROJECTILE HARDNESS 196/207 BHN.					
15	570	500	.025	-	8.165	12	307.8 3982 T	N. .016	
16	570	500	.025	-	8.165	12	307.8 4290 T	N. .0165	

**NOTES:** Chip condition - 1/4" diameter curl - maximum length 2", mostly single roll chips.

**TABLE 55: DATA FOR LIFE LINES**

<b>Date:</b>	9/16/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E-68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 179/187 BHN.					
17	570	500	.025	-	8.150	12	307.2 4597 T.	.017	
18	570	500	.025	-	8.150	12	307.2 4904 T.	.017	
				PROJECTILE HARDNESS - 196/207 BHN.					
1	570	800	.025	-	8.089	6	152.5	.007	
1a	570	800	.025	-	8.089	6	152.5 305 T.	.0095	481 .015
2	570	1000	.025	-	8.089	6	152.5	.012	190 .015

NOTES:

TABLE 56: DATA FOR LIFE LINES



<b>Date:</b> 9/17/81					<b>Material:</b> 4140				
<b>Depth of Cut:</b> APPROX. .100					<b>Coolant:</b> TRIM-SOL 20:1				
<b>Hardness:</b> SEE TAB					<b>Tool Description:</b>				
<b>Coolant Application:</b> TOP					<b>Holder:</b> CCGNR-164				
					<b>Insert:</b> CNG-454 820				
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
1	G-10	1400	.015	-	8.129	3	76.6	.004	287   .015
2	G-10	1200	.015	-	8.129	9	229.8	.010	344   .015
1	G-10	900	.015	-	8.129	12	306.5	.002F	NOTE 1
2	G-10	900	.015	-	8.089	12	304.9 611 T	.0035F	NOTE 2
3	G-10	900	.015	-	8.089	12	304.9 916 T	.0045F	NOTE 3
1	G-10	1000	.015	-	8.074	12	-	-	NOTE 4

**NOTES:**  
1. CHIPS - 1/2" DIA. CURL - 2" to 4" LONG.  
2. CHIPPING ON FLANK AT "EDGE OF WORK" AREA.  
3. CHIPPING ON FLANK AT "EDGE OF WORK" AREA - .060" HIGH BY .150" WIDE - TEST STOPPED.  
4. CHIPPING ON FLANK AT "EDGE OF WORK" AREA.

**TABLE 57: DATA FOR LIFE LINES**

<b>Date:</b> 9/17/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454 2020

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 187/196 BHN.					
1	G-10	1000	.015	-	8.074	12	-	-	NOTE 1
				NEW INSERT - PROJECTILE HARDNESS 187/196 BHN.					
1	G-10	800	.015	-	8.145	12	307	.003	
2	G-10	800	.015	-	8.145	12	307 604 T		NOTE 1

**NOTES:**  
 1. CHIPPING ON FLANK AT "EDGE OF WORK" AREA - TEST STOPPED.

**TABLE 58: DATA FOR LIFE LINES**

<b>Date:</b>	9/18/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454 - 820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 196/207 BHN.					
1	G-30	900	.015	-	8.096	6	-	-	NOTE 1
				NEW CUTTING EDGE					
1	G-30	1100	.015	-	8.096	6	-	-	NOTE 2
				45° LEAD ANGLE HOLDER-INSERT SNG-554 820					
1	G-30	1100	.015	-	8.096	6	-	-	NOTE 3
				NEW INSERT - SNG-554 - 12 X 30					
1	G-30	1100	.015	-	8.096	6	152.6	.002	
				PROJECTILE HARDNESS - 187/196 BHN.					
2	G-30	1100	.015	-	8.117	12	306 459 T	.023	NOTE 4 239 .012
				NEW INSERT					
1	G-30	1000	.015	-	8.117	12	306	.0045	NOTE 5

**NOTES:**

1. NOTCH AT "EDGE OF WORK" AREA - TEST STOPPED.
2. NOTCH AT "EDGE OF WORK" AREA - TEST STOPPED.
3. CHIPPED LEADING EDGE OF TOOL - FULL LENGTH.
4. WEAR-LAND IN "EDGE OF WORK" AREA - NO CHIPPING.
5. WEAR-LAND IN "EDGE OF WORK" AREA - NO CHIPPING ON FLANK EDGE OF TOOL.

**TABLE 59: DATA FOR LIFE LINES**



<b>Date:</b> 9/18/81 <b>Depth of Cut:</b> APPROX. .100 <b>Hardness:</b> SEE TAB <b>Coolant Application:</b> NONE	<b>Material:</b> 4140 <b>Coolant:</b> NONE <b>Tool Description:</b> <b>Holder:</b> CSDNN-165 <b>Insert:</b> SNG-554 12 X 30
---	---

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE	HARDNESS	170/187 BHN.			
1	G-30	850	.015	-	8.097	12	305.2	.0135*	
				PROJECTILE	HARDNESS	179/187 BHN.			
2	G-30	850	.015	-	8.145	12	307 612 T	.015*	
3	G-30	850	.015	-	8.145	12	307 919 T	.0175*	
				PROJECTILE	HARDNESS	187/202 BHN.			
4	G-30	850	.015	-	8.086	12	304.8 1224 T	.035 N. .0185*	NOTE 1
					NEW INSERT				
1	G-30	850	.015	-	8.126	12	306.3	.006*	
				PROJECTILE	HARDNESS	187 BHN.			
2	G-30	850	.015	-	8.120	12	306.1 612 T	.0075*	
3	G-30	850	.015	-	8.120	12	306.1 918 T	.0085*	

**NOTES:** \* WEAR LAND ON FLANK AT "EDGE OF WORK".

1. BAD OUT-OF-ROUND CONDITION - DID NOT CLEAN UP ON ONE SIDE - NOSE RADIUS GOING IN AND OUT OF WORK EVERY REVOLUTION OF WORKPIECE.

**TABLE 61: DATA FOR LIFE LINES**

<b>Date:</b>	9/18/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CSDNN-165
		<b>Insert:</b>	SNG-554 12 X 30

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 170			BHN.		
4	G-30	850	.015	-	8.126	12	306.3 1224 T	.005F .0105*	
5	G-30	850	.015	-	8.126	12	306.3 1530 T	.007F .0115*	
				PROJECTILE HARDNESS - 196			BHN.		
6	G-30	850	.015	-	8.126	12	306.3 1836 T	.008F .015*	
7	G-30	850	.015	-	8.126	12	306.3 2142 T	.009F .0165*	
				DATE 9/21/81 - PROJECTILE HARDNESS 179/187			BHN.		
8	G-30	850	.015	-	8.140	12	306.3 2449 T	.010F .020*	
9	G-30	850	.015	-	8.140	12	306.9 2758 T	.011F .024*	NOTE 1

**NOTES:** \* WEAR LAND ON FLANK AT "EDGE OF WORK".

1. NO CHIPPING ON INSERT - CRATER OF TOP FACE  
BACK OF CHAMFER - MAX. CRATER IN "EDGE OF WORK" AREA.

**TABLE 62: DATA FOR LIFE LINES**



<b>Date:</b> 9/21/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CSDNN-165	
		<b>Insert:</b> SNG-554 12 X 30	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE	HARDNESS	187/196 BHN.			
1	G-30	850	.015	-	8.125	12	306.3	.005*	
2	G-30	850	.015	-	8.125	12	306.3 612 T	.007*	NOTE 1
				PROJECTILE	HARDNESS	187/196 BHN.			
3	G-30	850	.015	-	8.080	12	304.6 918 T	.005F .0085*	
4	G-30	850	.015	-	8.080	12	304.6 1222 T	.0065F .013*	NOTE 2
				PROJECTILE	HARDNESS	179/187 BHN.			
5	G-30	850	.015	-	8.055	12	303.7 1526T	.009F .016*	
6	G-30	850	.015	-	8.055	12	303.7 1830 T	.013F .021*	NOTE 3
				PROJECTILE	HARDNESS	187/207 BHN.			
7	G-30	850	.015	-	8.096	12	305.2 2135 T	.014F .024*	
8	G-30	850	.015	-	8.096	12	305.2 2440 T	.016 .026*	

**NOTES:** \* WEAR-LAND ON FLANK AT "EDGE OF WORK".

1. SMALL BUILDUP ON NOSE RADIUS.
2. WEAR-LAND NOT AS UNIFORM AS PREVIOUS TEST.
3. CHIPPED CUTTING EDGE AT INTERSECTION OF NOSE RADIUS AND LEADING EDGE-MAX. FLANK WEAR AT THIS POINT.

**TABLE 63: DATA FOR LIFE LINES**

<b>Date:</b> 9/21/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CSDNN-165
	<b>Insert:</b> SNG-554 2020

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS 179/187 BHN.					
1	G-30	850	.022	-	8.112	6	152.9	-	NOTE 1
2	G-30	850	.022	-	8.112	6	152.9 306 T	.005*	NOTE 2
				NEW INSERT SNG-554 12 X 30					
1	G-30	850	.022	-	8.112	6	152.9		
2	G-30	850	.022	-	8.112	6	152.9 306 T	.008*	
				PROJECTILE HARDNESS 179/187 BHN.					
3	G-30	850	.022	-	8.091	12	305 611 T	.009*	
4	G-30	850	.022	-	8.091	12	305 916 T	.004F .0095*	
				DATE 9/22/81 - PROJECTILE HARDNESS - 187 BHN.					
5	G-30	850	.022	-	8.059	12	303.8 1220 T	.006F .013*	
6	G-30	850	.022	-	8.059	12	303.8 1524 T	.022F .036*	

**NOTES:** \* WEAR-LAND ON FLANK AT "EDGE OF WORK" AREA.

1. CHIPPED CHAMFER .200 TO .300 FROM NOSE RADIUS

2. CHIPPED CHAMFER .150 TO .350 FROM NOSE RADIUS TEST STOPPED.

**TABLE 64: DATA FOR LIFE LINES**



**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 4140

**HARDNESS:** 196/207 BHN.

**INSERT:** TNMG-433  
E-68  
**GRADE:** 570

**SURFACE FEED:** 500

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**FEEDRATE:** .025 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	380	150	220
.100	740	330	280
.150	960	520	340
.200	1400	700	420

**INSERT:** SNG-554  
.012 x 30°  
**GRADE:** G-30

**SURFACE FEED:** 850

**COOLANT:** NONE  
HOLDER  
45° L.A.

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	290	170	300
.100	540	330	520
.150	800	500	760
.200	1040	660	960

**INSERT:**

**SURFACE FEED:**

**COOLANT:**

**GRADE:**

**FEEDRATE:**

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD

**TABLE 66: DATA FOR LIFE LINES**

## TOOL LOAD VERSUS DEPTH OF CUT

Material: 4140

Holder: CTANR-164

Hardness: 196/207 BHN.

Insert: TNMG-433E 68

Feed Rate: .025 IN./REV.

Grade: 570

Surface Speed: 500 FT./MIN.

Coolant: TRIM-SOL 20:1 TOP

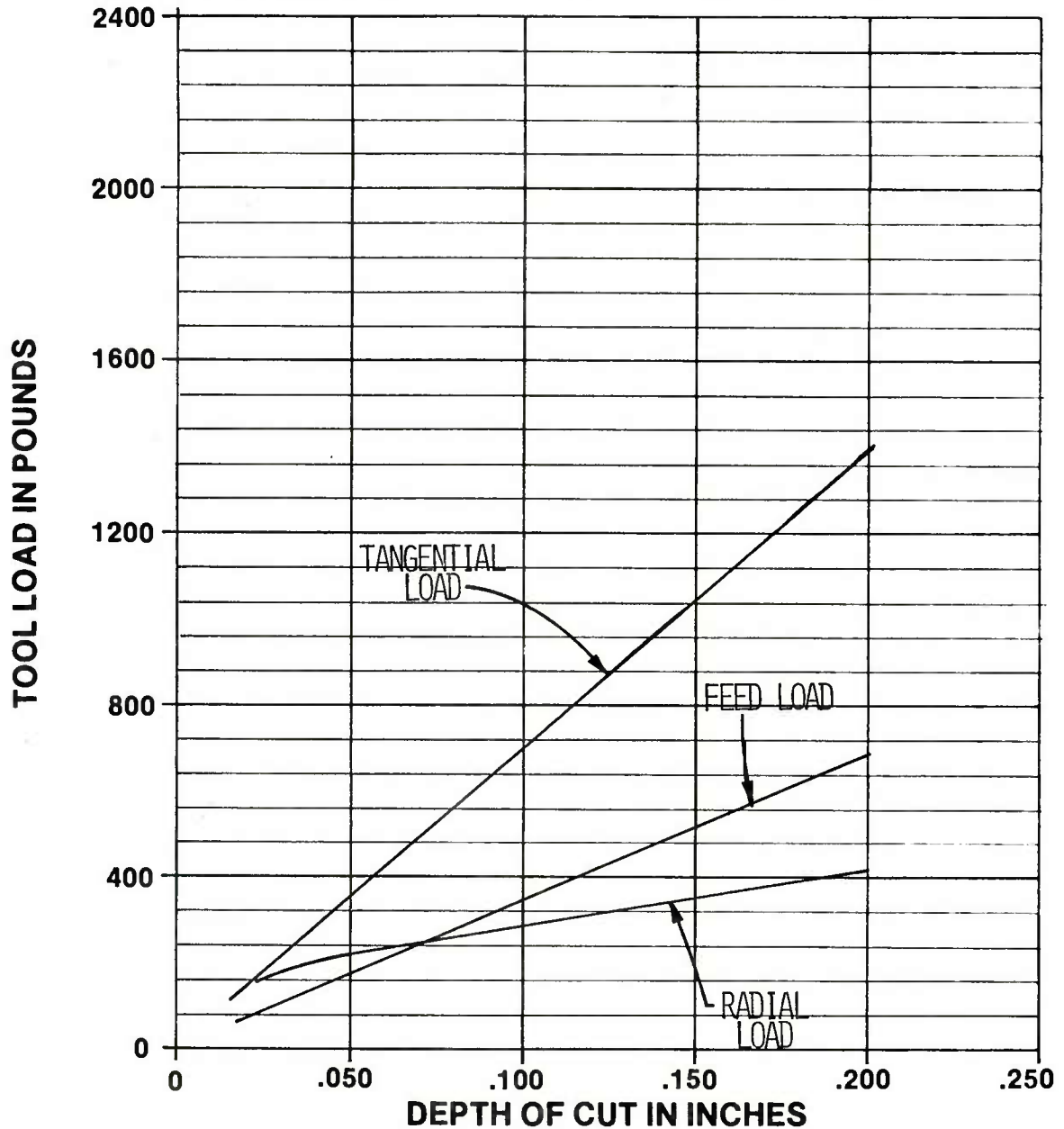


FIGURE 43: TOOL LOAD CHART

## TOOL LOAD VERSUS DEPTH OF CUT

Material: 4140

Holder: CSDNN-165

Hardness: 196/207 BHN.

Insert: SNG-554 1230

Feed Rate: .015 IN./REV.

Grade: G-30

Surface Speed: 850 FT./MIN.

Coolant: NONE

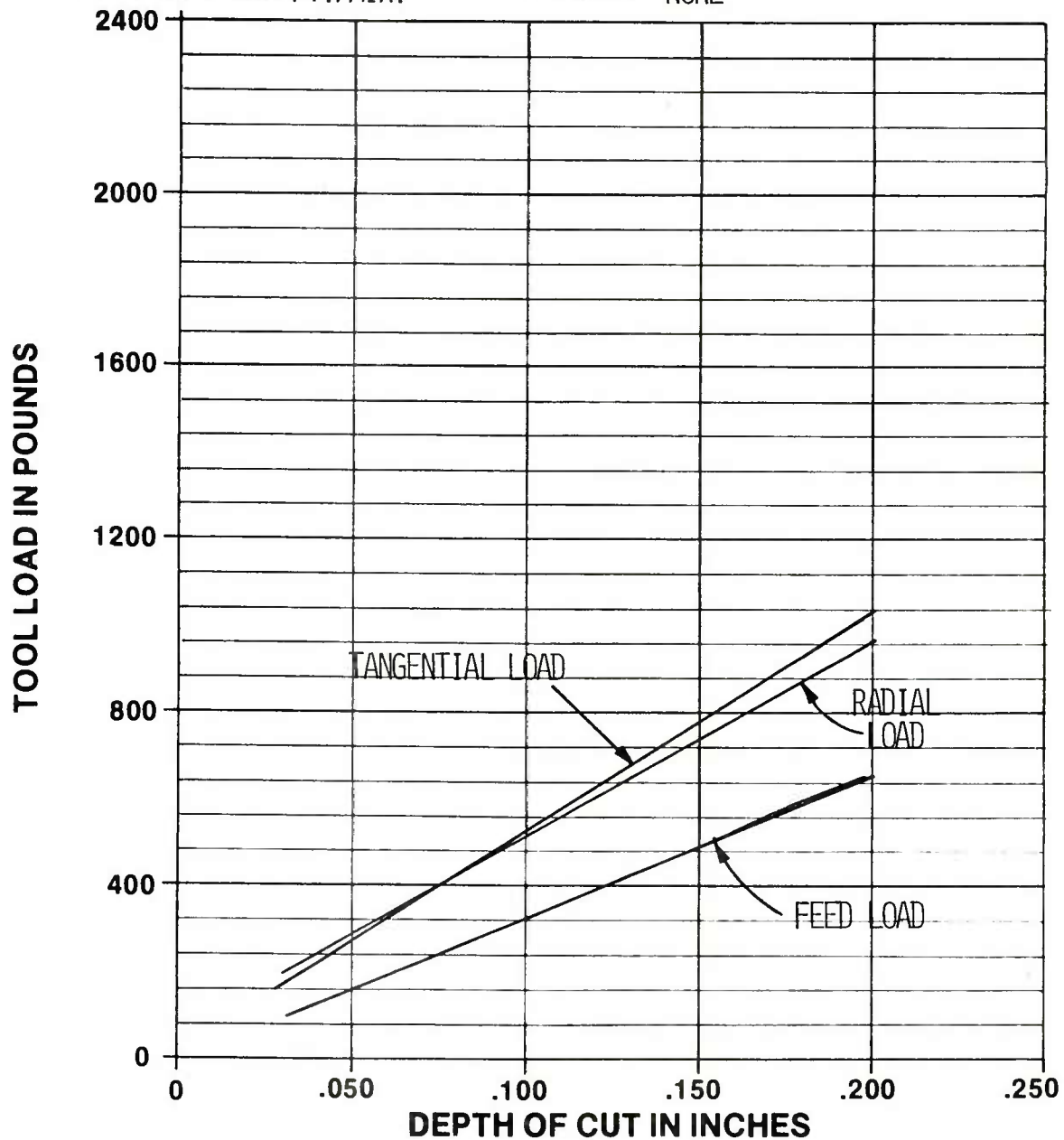


FIGURE 44: TOOL LOAD CHART



<b>Date:</b> 12/22/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> -
<b>Hardness:</b> SEE CHART	<b>Tool Description:</b>
<b>Coolant Application:</b> -	<b>Holder:</b> SEE CHART
	<b>Insert:</b> SEE CHART

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
	570	340	.015	(FROM CONFIRMATION TESTS)					3500   .015
	570	370	.015	(FROM CONFIRMATION TESTS)					2000   .015
	570	400	.015	(FROM CONFIRMATION TESTS)					1300   .015
	570	550	.015	(FROM CONFIRMATION TESTS)					300   .015
	G-30	600	.015	(FROM CONFIRMATION TESTS)					4000   .015
	G-30	650	.015	(FROM CONFIRMATION TESTS)					3000   .015
	G-30	1000	.015	(FROM CONFIRMATION TESTS)					390   .015
	G-10	650	.015	(FROM CONFIRMATION TESTS)					1500   .012
	G-10	700	.015	(FROM CONFIRMATION TESTS)					1200   .012
	G-10	850	.015	(FROM CONFIRMATION TESTS)					430   .012

**NOTES:**

**TABLE 67: DATA FOR LIFE LINES**

<b>Date:</b> 12/21/81				<b>Material:</b> 4140					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 402 BHN.					
1	570	400	.015	-	8.026	4.200	105.9	.005	NOTE 1
2	570	400	.015	-	8.026	6.000	151.3 257 T.	.0065	
3	570	400	.015	-	8.026	6.000	151.3 408 T.	.007+	
4	570	400	.015	-	8.026	6.000	151.3 559 T.	.008	
				PROJECTILE HARDNESS - 387/418 BHN.					
5	570	400	.015	-	8.041	11.600	293 852 T.	.0085	NOTE 2
6	570	400	.015	-	8.041	12.000	303.1 1155 T.	.010	
				PROJECTILE HARDNESS -387/402 BHN.					
7	570	400	.015	-	8.021	11.400	287.3 1442 T.	.019 N.	(NOSE WEAR)
	- NEW INSERT -								
1	570	550	.015	-	8.025	11.900	300	.015	

**NOTES:**  
NOTE 1 - CHIP-CONDITION 1/2" diam. roll 10" to 20" long.  
NOTE 2 - If the chip-flow is restricted, the chip then becomes uncontrollable.

TABLE 68: DATA FOR LIFE LINES

<b>Date:</b> 12/21/81		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387			BHN.		
1	570	340	.015	-	8.040	5.600	141.4	.005	NOTE 1
2	570	340	.015	-	8.040	6.000	151.6 293 T.	.006	
3	570	340	.015	-	8.040	6.000	151.6 445 T.	.0065	
4	570	340	.015	-	8.040	6.000	151.6 597 T.	.0075	
DATE 12/22/81				PROJECTILE HARDNESS - 387			418 BHN.		
5	570	340	.015	-	8.029	11.500	290 887 T.	.0085	
6	570	340	.015	-	8.029	12.000	302.7 1190 T.	.0095	
				PROJECTILE HARDNESS - 418			BHN.		
7	570	340	.015	-	8.081	11.400	289.4 1479 T.	.010	
8	570	340	.015	-	8.081	12.000	304.6 1784 T.	.011	

**NOTES:**  
NOTE 1 - Chip condition 5/8" to 3/4" diam. continuous roll.

TABLE 69: DATA FOR LIFE LINES

<b>Date:</b>	12/22/81	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. -.050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 387/418 BHN.		
9	570	340	.015	-	8.065	11.500	291.3 2075 T.	.0115	
10	570	340	.015	-	8.065	12.000	304 2379 T.	.012	
							PROJECTILE HARDNESS - 418 BHN.		
11	570	340	.015	-	8.017	11.400	287.1 2666 T.	.0125	
12	570	340	.015	-	8.017	12.000	302.2 2968 T.	.0135	
							PROJECTILE HARDNESS - 387/417 BHN.		
13	570	340	.015	-	8.022	11.500	289.8 3258 T.	.0145	
14	570	340	.015	-	8.022	12.000	302.4 3560 T.	.0155	
							PROJECTILE HARDNESS - 387 BHN.		
15	570	340	.015	-	8.018	11.500	289.7 3850 T.	.017	
16	570	340	.015	-	8.018	6.000	151 4001 T.	.0185	
17	570	340	.015	-	8.018	6.000	151 4152 T.	.0205	

**NOTES:**

**TABLE 70: DATA FOR LIFE LINES**

<b>Date:</b> 12/22/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .050	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364/387 BHN.					
1	570	370	.015	-	8.026	5.700	143.7	.005	
2	570	370	.015	-	8.026	6.000	151.3 295 T.	.0065	
3	570	370	.015	-	8.026	6.000	151.3 446 T.	.0070	
4	570	370	.015	-	8.026	5.200	131.1 577 T.	.0075	
				PROJECTILE HARDNESS - 387 BHN.					
5	570	370	.015	-	8.050	11.600	293.4 870 T.	.0085	
6	570	370	.015	-	8.050	12.000	303.5 1173 T.	.009	
				PROJECTILE HARDNESS - 418 BHN.					
7	570	370	.015	-	8.021	11.400	287.3 1460 T.	.010	
8	570	370	.015	-	8.021	12.000	302.4 1762 T.	.011	

**NOTES:**

**TABLE 71: DATA FOR LIFE LINES**



[illegible]**TABLE 72: DATA FOR LIFE LINES**



<b>Date:</b> 12/29/81	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> NCNE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387		BHN.			
1	G-30	600	.015	-	8.064	6.000	152	.0035	NOTE 1
				PROJECTILE HARDNESS - 418		BHN/			
2	G-30	600	.015	-	8.070	11.600	294 446 T.	.010 W. .005 N.	
3	G-30	600	.015	-	8.070	12.000	304 750 T.	.010 W. .0065 N.	
				PROJECTILE HARDNESS - 387		BHN.			
4	G-30	600	.015	-	8.058	11.700	296.2 1046 T.	.010 W. .007	
5	G-30	600	.015	-	8.058	12.000	303.8 1350 T.	.010 W. .0075	
				PROJECTILE HARDNESS - 387		BHN.			
6	G-30	600	.015	-	8.004	11.700	294.2 1644 T.	.012 W. .0085 N.	
7	G-30	600	.015	-	8.004	12.000	301.7 1946 T.	.0125 W. .0095 N.	

**NOTES:**

W - Wear land at "edge of work" area.

N - Wear land on nose radius.

1 - Chip condition - 1/4" diameter roll 8" to 10" long.

**TABLE 73: DATA FOR LIFE LINES**



<b>Date:</b> 1/4/82	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 387 BHN.		
1	G-30	650	.015	-	8.088	11.500	292.2	.004	NOTE 1
							PROJECTILE HARDNESS - 387/418 BHN.		
2	G-30	650	.015	-	8.011	11.700	294.5 587 T.	.005	
3	G-30	650	.015	-	8.011	11.700	294.5 882 T.	.006	
							PROJECTILE HARDNESS - 387 BHN.		
4	G-30	650	.015	-	8.023	11.700	294.9 1177 T.	.0075 <sup>+</sup>	
5	G-30	650	.015	-	8.023	11.800	297.4 1474 T.	.0085	
							PROJECTILE HARDNESS - 364/387 BHN.		
6	G-30	650	.015	-	7.967	11.700	292.8 1767 T.	.010	
7	G-30	650	.015	-	7.967	11.800	295.3 2062 T.	.011	

**NOTES:**  
 1 - Chip-condition 1/4" diameter roll, 1" to 3" long.

**TABLE 75: DATA FOR LIFE LINES**

<b>Date:</b> 1/4/82				<b>Material:</b> 4140			
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> NONE			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> NONE				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-454-820			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364/387 BHN.					
8	G-30	650	.015	-	8.065	11.700	296.4 2358 T.	.012	
9	G-30	650	.015	-	8.065	12.000	304 2662 T.	.013	
				PROJECTILE HARDNESS - 387 BHN.					
10	G-30	650	.015	-	8.052	11.700	295.9 2958 T.	.0145	
11	G-30	650	.015	-	8.052	12.000	303.6 3262 T.	.0155	3000 .015
				PROJECTILE HARDNESS - 364 BHN.					
1	G-30	1000	.015	-	8.019	8.800	221.7	.0085	391 .015

**NOTES:**

**TABLE 76: DATA FOR LIFE LINES**

<b>Date:</b> 1/4/82	<b>Material:</b> 4140
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b>	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 364 BHN.		
1	G-10	650	.015	-	8.019	6.000	151.2	.002	NOTE 1
2	G-10	650	.015	-	8.019	9.000	226.7 378 T.	.004	NOTE 2
							PROJECTILE HARDNESS - 387 BHN.		
3	G-10	650	.015	-	8.021	11.700	294.8 673 T.	.005	NOTE 3
4	G-10	650	.015	-	8.021	12.000	302.4 975 T.	.007	
							PROJECTILE HARDNESS - 418 BHN.		
5	G-10	650	.015	-	8.029	4.800	121.0 1096 T.	.008	NOTE 4

**NOTES:**  
 1 - Chip-condition 1/4" diameter roll, 2" to 3" long.  
 2 - Slight chip in chamfer at "edge of work" line.  
 3 - Chip did not enlarge during run.  
 4 - Insert had chip in leading edge at "edge of work" area - increases noted in tangential and feed loads - test stopped before catastrophic failure.

**TABLE 77: DATA FOR LIFE LINES**





<b>Date:</b> 1/5/82				<b>Material:</b> 4140					
<b>Depth of Cut:</b> APPROX. -.050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
1	G-10	700	.015	-	8.083	9.500	241.2	.003	
2	G-10	700	.015	-	8.083	12.000	304.7 546 T.	.0045	
				PROJECTILE HARDNESS - 387			BHN.		
3	G-10	700	.015	-	7.982	11.700	293.4 839 T.	.0065	
4	G-10	700	.015	-	7.982	11.800	295.9 1135 T.	.008	
1/6/82				PROJECTILE HARDNESS -387			BHN.		
5	G-10	700	.015	-	8.023	8.600	216.8 1352 T.	.009	NOTE 1
6	G-10	700	.015	-	8.023	9.000	226.8 1579 T.	.010	
1/7/82				PROJECTILE HARDNESS - 364			BHN.		
7	G-10	700	.015	-	7.970	11.700	293 1872 T.	.0115	
8	G-10	700	.015	-	7.970	11.700	293 2165 T.	.013	NOTE 2

**NOTES:**  
1 - Slight crater on top flank.  
2 - Size of crater area increasing.

TABLE 79: DATA FOR LIFE LINES



<b>Date:</b> 1/8/82				<b>Material:</b> 4140					
<b>Depth of Cut:</b> APPROX. .050				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-820					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 418 BHN.					
1	G-10	700	.015	-	7.992	4.600	116.5	.000 <sup>+</sup>	
				PROJECTILE HARDNESS -418 BHN.					
2	G-10	700	.015	-	8.005	9.600	241.4 357 T.	.006	
3	G-10	700	.015	-	8.005	11.800	296.7 654 T.	.0075	
1/1/82				PROJECTILE HARDNESS - 387 BHN.					
4	G-10	700	.015	-	8.040	12.000	303.1 957 T.	.0095	NOTE 1
5	G-10	700	.015	-	8.040	11.900	300.6 1258 T.	.011	
				PROJECTILE HARDNESS - 387 BHN.					
6	G-10	700	.015	-	8.001	12.000	301.6 1560 T.	.0125	NOTE 2
7	G-10	700	.015	-	8.001	4.500	113.1 1673 T.		NOTE 3

**NOTES:**  
1 - "Large" crater on top flank of tool - does not appear ready to break out - test continued - "banding" on turned surface.  
2 - Small "nick" on wear-land in "edge of work" area - poor blend of nose radius and flank on this insert - not cam ground.  
3 - Tool failed.

**NOTES:**

- 1 - "Large" crater on top flank of tool - does not appear ready to break out - test continued - "banding" on turned surface.
- 2 - Small "nick" on wear-land in "edge of work" area - poor blend of nose radius and flank on this insert - not cam ground.
- 3 - Tool failed.

**TABLE 81: DATA FOR LIFE LINES**

<b>Date:</b> 1/11/82		<b>Material:</b> 4140	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387 BHN.				NOTE 1	
1	G-10	700	.015	-	8.031	11.600	292.7	.0045	
2	G-10	700	.015	-	8.031	11.800	297.7 590 T.	.0075	NOTE 2
				PROJECTILE HARDNESS - 387 BHN.					
3	G-10	700	.015	-	8.025	12.100	305 895 T.	.0085	
4	G-10	700	.015	-	8.025	11.600	292.5 1187 T.	.011	NOTE 3
				PROJECTILE HARDNESS - 387 BHN.					
5	G-10	700	.015	-	8.022	12.300	310 1497 T.	.013	NOTE 4

**NOTES:**

1 - Wider chip - breaker used - with no coolant.

2 - Chip-condition - 1/4" diameter continuous roll, 8" to 10" long.

3 - Chip-condition - 1/4" diameter continuous roll, 2" to 4" long.

4 - Insert had chip in edge of work area, where crater went to flank - test stopped - nose radius in good condition.

**TABLE 82: DATA FOR LIFE LINES**

<b>Date:</b>	1/12/82	<b>Material:</b>	4140
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387 BHN.					
1	G-10	650	.015	-	8.022	11.800	297.4	.004	
				PROJECTILE HARDNESS - 387 BHN.					
2	G-10	650	.015	-	8.031	12.100	305.3 603 T.	.0065	NOTE 1
3	G-10	650	.015	-	8.031	11.600	292.7 896 T.	.008	
				PROJECTILE HARDNESS - 387 BHN.					
4	G-10	650	.015	-	8.013	11.700	294.5 1191 T.	.0095	NOTE 2
5	G-10	650	.015	-	8.013	11.800	297 1488 T.	.011	
				PROJECTILE HARDNESS - 387 BHN.					
6	G-10	650	.015	-	8.070	1.400	38 1526 T.	-	NOTE 3
	- NEW INSERT -								
1	G-10	850	.015	-	8.064	5.700	144.4	.004	433 .012

**NOTES:**

- 1 - Chip-condition 1/4" diameter roll, 1/2" to 1" long - Spec. c/b.
- 2 - Chip-condition - 1/4" diameter roll, 8" to 10" long - crater on top flank of tool.
- 3 - Nose of tool broke out where crater met flank and rear of nose radius.

**TABLE 83: DATA FOR LIFE LINES**



**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 4140

**HARDNESS:** 387 BHN.

**INSERT:** TNMG-433  
E-48

**SURFACE FEED:** 360

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** 570

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	140	60	120
.050	280	140	170
.100	540	290	220
.150	820	440	270

**INSERT:** CNG-454  
820

**SURFACE FEED:** 670

**COOLANT:** NONE

**GRADE:** G-30

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	120	40	110
.050	250	100	160
.100	540	280	190
.150	820	580	220

**INSERT:** CNG-454  
820

**SURFACE FEED:** 700

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** G-30

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	140	40	100
.050	260	100	150
.100	500	250	200
.150	760	400	250

**TABLE 84: DATA FOR TOOL LOAD CHARTS**



### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 4140

**HOLDER:** CTANR-164

**HARDNESS:** 387 BHN.

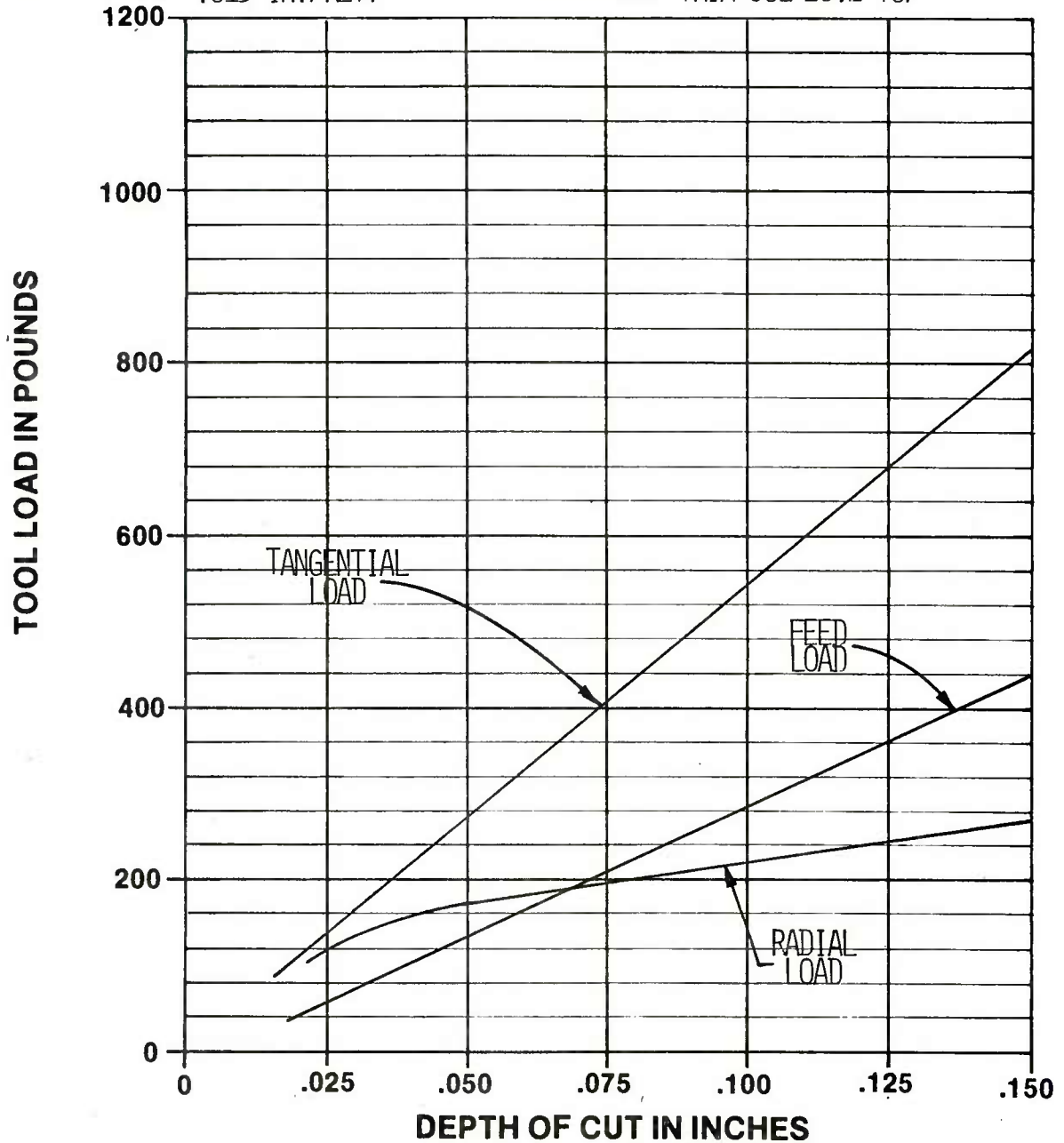
**INSERT:** TNMG-433E48

**SURFACE SPEED:** 360 FT./MIN.

**GRADE:** 570

**FEED RATE:** .015 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 45: TOOL LOAD CHART**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 4140

**HOLDER:** CCGNR-164

**HARDNESS:** 387 BHN.

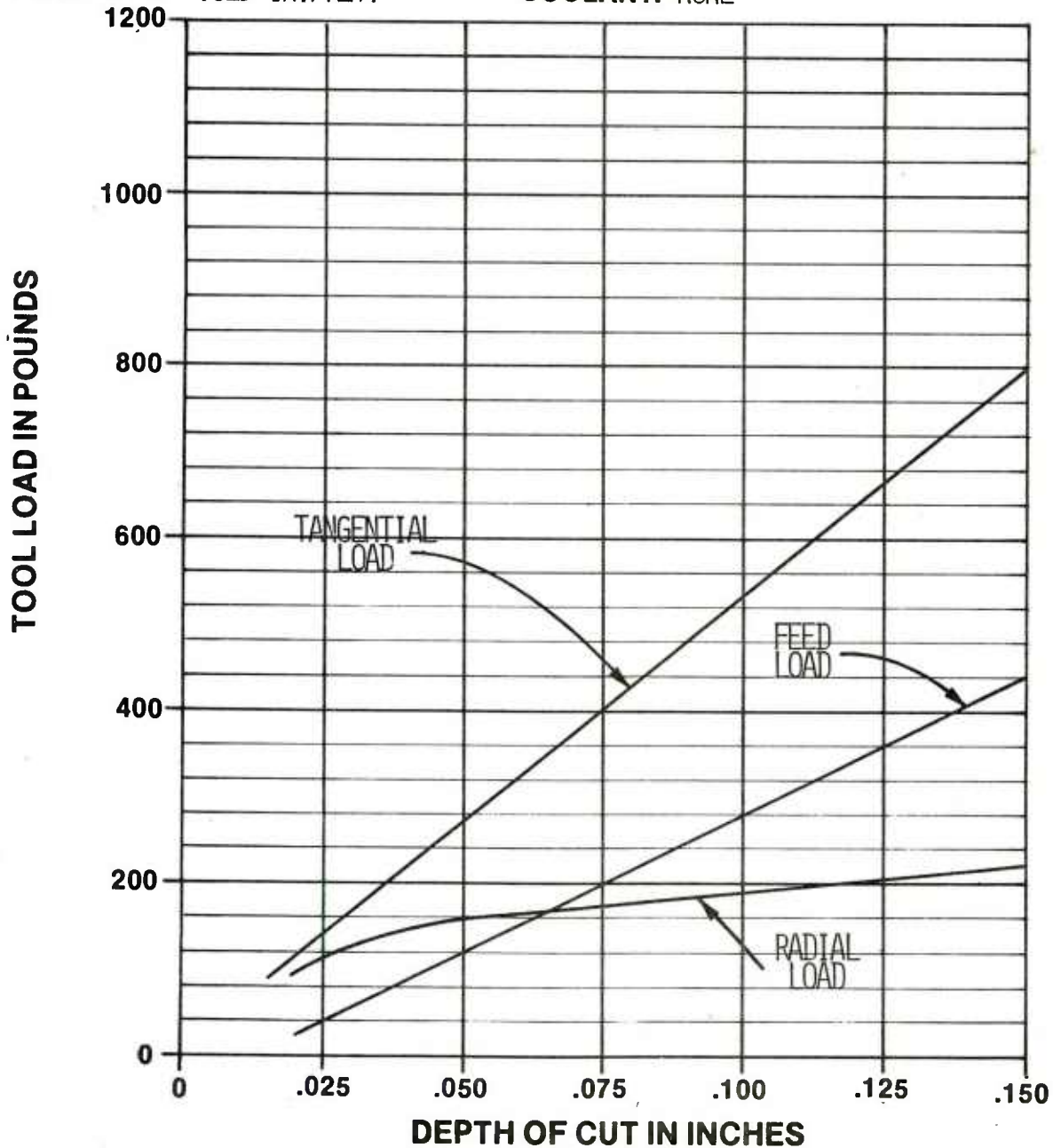
**INSERT:** CNG-454-820

**SURFACE SPEED:** 670 FT./MIN.

**GRADE:** G-30

**FEED RATE:** .015 IN./REV.

**COOLANT:** NONE



**FIGURE 46: TOOL LOAD CHART**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 4140

**HOLDER:** CCGNR-164

**HARDNESS:** 387 BHN.

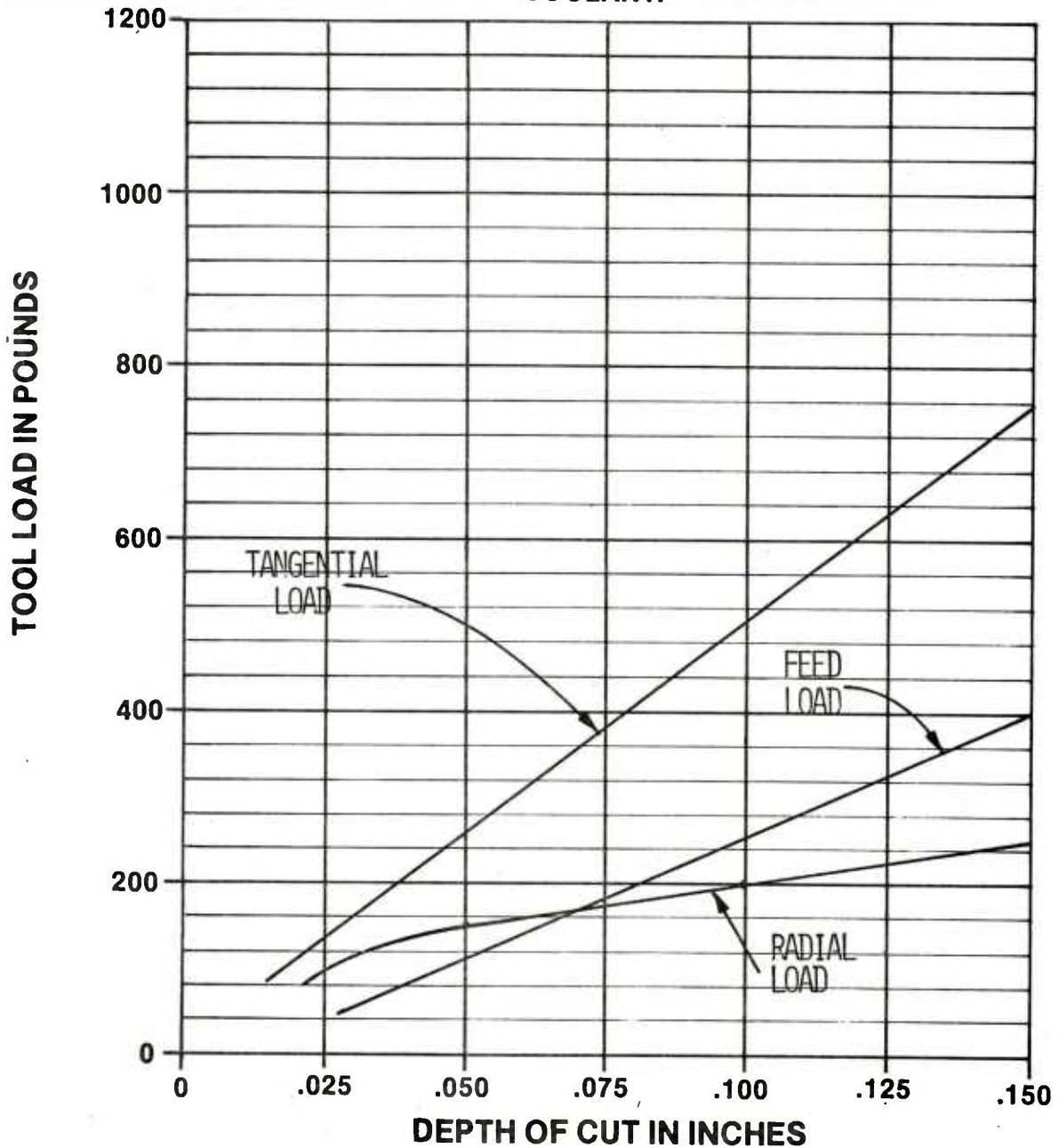
**INSERT:** CNG-454-820

**SURFACE SPEED:** 700 FT./MIN.

**GRADE:** G-10

**FEED RATE:** .015 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 47: TOOL LOAD CHART**

<b>Date:</b>	10/26/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100"	<b>Coolant:</b>	
<b>Hardness:</b>	SEE GRAPH	<b>Tool Description:</b>	
<b>Coolant Application:</b>		<b>Holder:</b>	
		<b>Insert:</b>	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 241 BHN.					
	570	1000	.022	-	6.080	2.700	52	.007	134   .018
	570	800	.022	-	6.080	4.400	84	.0055	275   .018
	570	400	.022	(FROM CONFIRMATION TEST)					3400   .018
	G-30	1000	.015	-	-	-	538	.0085	950   .015
	G-30	1400	.015	-	-	-	218	.0065	500   .015
	G-30	700	.015	(FROM CONFIRMATION TESTS)					2800   .015
	G-10	1000	.015	-	-	-	441	.007	945   .015
	G-10	800	.015	(FROM CONFIRMATION TESTS)					2000   .015

**NOTES:**

**TABLE 85: DATA FOR LIFE LINES**

<b>Date:</b> 9/28/81				<b>Material:</b> 4340			
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433E68			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND	
				MOTOR BODY HARDNESS - 217/228 BHN.						
1	570	400	.033	-	6.204	7.100	138.4	.006		
				MOTOR BODY HARDNESS - 241 BHN.						
2	570	400	.033	-	6.214	6.400	125 263 T.	.007		
	DATE 9/29/81 -				MOTOR BODY HARDNESS - 255/269 BHN.					
3	570	400	.033	-	6.102	8.100	155 418 T.	.0075		
				MOTOR BODY HARDNESS - 241 BHN.						
4	570	400	.033	-	6.095	6.900	132.1 550 T.	.0095		
				MOTOR BODY HARDNESS 255/269 BHN.						
5	570	400	.033	-	6.098	8.400	160.9 711 T.	.011		
				MOTOR BODY HARDNESS - 269 BHN.						
6	570	400	.033	-	6.114	9.100	174.8 886 T.	.011		

NOTES:

**TABLE 86: DATA FOR LIFE LINES**

<b>Date:</b>	9/29/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS — 286 BHN.					
7	570	400	.033	-	6.108	8.500	163.1 1049 T.	.0125	
				MOTOR BODY HARDNESS — 241/255 BHN.					
8	570	400	.033	-	6.138	6.500	125.3 1174 T.		
				MOTOR BODY HARDNESS — 241/255 BHN.					
9	570	400	.033	-	6.127	7.700	148.2 1322 T.	.0175	
				MOTOR BODY HARDNESS — 241 BHN.					
10	570	400	.033	-	6.095	7.500	143.6 1466 T.	.018	
				MOTOR BODY HARDNESS — 228/255 BHN.					
11	570	400	.033	-	6.104	7.100	136.1 1602 T.	.018	
	DATE 9/30/81			MOTOR BODY HARDNESS — 241/255 BHN.					
12	570	400	.033	-	-	-	-		NOTE 1

**NOTES:**

1. Tool broke - no indication from Dynamometer - no "holes" in forging.

**TABLE 87: DATA FOR LIFE LINES**



<b>Date:</b> 9/30/81					<b>Material:</b> 4340				
<b>Depth of Cut:</b> APPROX. .100					<b>Coolant:</b> TRIM-SOL 20:1				
<b>Hardness:</b> SEE TAB					<b>Tool Description:</b>				
<b>Coolant Application:</b> TOP					<b>Holder:</b> CTANR-164				
					<b>Insert:</b> TNMG-433E68				

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 241 BHN.					
1	570	1000	.025	-	6.082	1.700	32.5	.008	61   .015
2	570	800	.025	-	6.082	4.400	84	.009	140   .015
				MOTOR BODY HARDNESS - 241 BHN.					
3	570	700	.025	-	6.125	6.400	123.2	.0075	246   .015
				MOTOR BODY HARDNESS - 241/255 BHN.					
1	570	550	.025	-	6.071	7.000	133.5	.007	
				MOTOR BODY HARDNESS - 241/255 BHN.					
2	570	550	.025	-	6.063	7.700	146.7 280 T.	.008	
				MOTOR BODY HARDNESS - 241/255 BHN.					
3	570	550	.025	-	6.115	6.900	132.6 413 T.	.0085	
				MOTOR BODY HARDNESS - 241/269 BHN.					
4	570	550	.025	-	6.085	8.900	170 583 T.	.0085	NOTE 1

**NOTES:**  
1. Insert turned for a length of 1.900, then nose cracked. Work diameter decreased by .003 inches, but finished rest of cut. Dynamometer load charts showed small decrease in load when breakage occurred.

**TABLE 88: DATA FOR LIFE LINES**

<b>Date:</b> 9/30/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E68

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 241 BHN.				
1	570	550	.025	-	6.100	7.300	140	.005	
				MOTOR BODY	HARDNESS - 241/255 BHN.				
2	570	550	.025	-	6.180	2.000	-	-	NOTE 1
				NEW INSERT - MOTOR BODY	HARDNESS - 241/255 BHN.				
1	570	550	.025	-	6.184	5.200	101	.0055	
				MOTOR BODY	HARDNESS - 255/269 BHN.				
2	570	550	.025	-	6.105	8.300	159 260 T.	.008	
				MOTOR BODY	HARDNESS - 255/269 BHN.				
3	570	550	.025	-	-	-	-	-	NOTE 2

**NOTES:**  
1. Workpiece slipped in chuck jaws. Insert does not show damage. Chuck Jaw Grippers ground with small flat-outside jaws ground to clear work.  
2. Tool broke near end of cut where run-out is maximum. Tool stop re-set to shorten turned length by .500".

**TABLE 89: DATA FOR LIFE LINES**

<b>Date:</b> 10/1/81				<b>Material:</b> 4340			
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433E68			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 241/255 BHN.				
1	570	450	.025	-	6.081	7.400	141.4	.005	NOTE 1
				MOTOR BODY	HARDNESS - 255/269 BHN.				
2	570	450	.025	-	6.100	6.700	128.4 270 T.	.006	
				MOTOR BODY	HARDNESS - 228/241 BHN.				
3	570	450	.025	-	6.090	7.800	149.2 419 T.	.007	
				MOTOR BODY	HARDNESS - 241/255 BHN.				
4	570	450	.025	-	6.142	6.900	133 552 .	.0075	
				MOTOR BODY	HARDNESS - 241/255 BHN.				
5	570	450	.025	-	6.100	6.900	132 684 T.	.008	
				MOTOR BODY	HARDNESS - 255/269 BHN.				
6	570	450	.025	-	-	-	-	-	NOTE 2

**NOTES:**  
1. Cutting speed was reduced when life-lines were redrawn - small mistake was noted in first calculation.  
2. Tool broke - no indication from Dynamometer, shell surface did not have "holes" in break area.

**TABLE 90: DATA FOR LIFE LINES**

<b>Date:</b> 10/1/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 269 BHN.				
1	570	375	.025	-	-	-	-	-	NOTE 1
				MOTOR BODY	HARDNESS - 241 BHN.				
1	570	1000	.022	-	6.080	2.700	52	.007	111 .015
2	570	800	.022	-	6.080	4.400	84	.0055	230 .015
				MOTOR BODY	HARDNESS - 241 BHN.				
3	570	700	.022	-	6.180	7.600	147.5	.0065	340 .015
				MOTOR BODY	HARDNESS - 241 BHN.				
1	570	400	.022	-	6.106	6.600	126.6	.005	NOTE 2
				MOTOR BODY	HARDNESS - 286 BHN.				
2	570	400	.022	-	6.117	5.500	105.7 232 T.	.006	
				MOTOR BODY	HARDNESS - 228/255 BHN.				
3	570	400	.022	-	6.115	6.000	115.3 347 T.	.0065	

**NOTES:**

1. Tool broke 1/2" from end of cut - no visible indication from load charts or workpiece - chip thickness approx. .045.
2. Chip thickness approx. .028".

**TABLE 91: DATA FOR LIFE LINES**

<b>Date:</b> 10/1/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS	- 241/255 BHN.				
4	570	400	.022	-	6.115	5.800	111.4 458 T.	.0075	
				MOTOR BODY HARDNESS	- 255 BHN.				
5	570	400	.022	-	6.104	6.000	115 573 T.	.0075	
				MOTOR BODY HARDNESS	- 255 BHN.				
6	570	400	.022	-	6.104	6.300	120.8 694 T.	.0085	
				MOTOR BODY HARDNESS	- 241 BHN.				
7	570	400	.022	-	6.117	6.100	117.2 811 T.	.009	
	DATE 10/2/81			MOTOR BODY HARDNESS	- 241 BHN.				
8	570	400	.022	-	6.112	5.700	109 920 T.	.009	
				MOTOR BODY HARDNESS	- 241/255 BHN.				
9	570	400	.022	-	6.109	7.900	152 1072 T.	.009	

**NOTES:**

**TABLE 92: DATA FOR LIFE LINES**



<b>Date:</b> 10/2/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNE DIAMETER	TURNE LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							MOTOR BODY HARDNESS - 241/255 BHN.		
10	570	400	.022	-	6.126	5.900	113.5 1186 T.	.010	
							MOTOR BODY HARDNESS - 241 BHN.		
11	570	400	.022	-	6.118	5.500	105.7 1292 T.	.011	
							MOTOR BODY HARDNESS - 241/255 BHN.		
12	570	400	.022	-	6.109	6.400	122.8 1415 T.	.0115	
							MOTOR BODY HARDNESS - 286 BHN.		
13	570	400	.022	-	6.108	6.900	132.4 1548 T.	.0115	
							MOTOR BODY HARDNESS - 269 BHN.		
14	570	400	.022	-	6.069	7.500	143 1691 T.	.012	
							MOTOR BODY HARDNESS - 255/269 BHN.		
15	570	400	.022	-	6.091	7.800	149.3 1840 T.	.012	

**NOTES:**

TABLE 93: DATA FOR LIFE LINES



<b>Date:</b>	10/2/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	— 255/285 BHN.			
16	570	400	.022	-	6.081	8.000	152.8 1993 T	.0125	
				MOTOR BODY	HARDNESS	— 269 BHN.			
17	570	400	.022	-	6.073	8.000	152.6 2146 T	.0125	
				MOTOR BODY	HARDNESS	— 241 BHN.			
18	570	400	.022	-	6.135	8.000	154.2 2300 T	.014	
				MOTOR BODY	HARDNESS	— 228/241 BHN.			
19	570	400	.022	-	6.124	5.400	103.9 2404 T	.0145	
				MOTOR BODY	HARDNESS	— 241 BHN.			
20	570	400	.022	-	6.114	6.000	115.2 2519 T	.0145	
				MOTOR BODY	HARDNESS	— 241 BHN.			
21	570	400	.022	-	6.105	6.000	115 2634 T	.015	

**NOTES:**

**TABLE 94: DATA FOR LIFE LINES**

<b>Date:</b> 10/2/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 286 BHN.				
22	570	400	.022	-	6.092	7.800	149.2 2782 T.	.015	
				MOTOR BODY	HARDNESS - 269/286 BHN.				
23	570	400	.022	-	6.115	7.400	142 2924 T.	.015	
				MOTOR BODY	HARDNESS - 255/269 BHN.				
24	570	400	.022	-	6.117	7.500	144 3068 T.	.0155	
				MOTOR BODY	HARDNESS - 269/286 BHN.				
25	570	400	.022	-	6.104	7.400	141.9 3210	.0165	

**NOTES:**

**TABLE 95: DATA FOR LIFE LINES**



<b>Date:</b> 10/7/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 286			BHN.		
7	570	400	.022	-	6.119	7.000	134.6 869 T.	.0095	
				MOTOR BODY HARDNESS - 228/			241 BHN.		
8	570	400	.022	-	6.127	5.200	100 969 T.	.0095	
				MOTOR BODY HARDNESS - 302/			321 BHN.		
9	570	400	.022	-	6.105	5.500	105.5 1074 T.	.010	
				MOTOR BODY HARDNESS - 228			BHN.		
10	570	400	.022	-	6.100	5.100	97.7 1172 T.	.011	
				MOTOR BODY HARDNESS - 228			BHN.		
11	570	400	.022	-	6.119	5.200	100 1272 T.	.0115	
	DATE 10/8/81			MOTOR BODY HARDNESS - 269			BHN.		
12	570	400	.022	-	6.100	7.000	134.1 1406 T.	.012	

**NOTES:**

**TABLE 97: DATA FOR LIFE LINES**

<b>Date:</b>	10/8/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 241/255 BHN.					
13	570	400	.022	-	6.130	5.300	102 1508 T.	.012	
				MOTOR BODY HARDNESS - 241 BHN.					
14	570	400	.022	-	6.088	6.800	130 1638 T.	.012	
				MOTOR BODY HARDNESS - 241/255 BHN.					
15	570	400	.022	-	6.108	5.600	107.4 1745 T.	.0125	
				MOTOR BODY HARDNESS - 269/302 BHN.					
16	570	400	.022	-	6.120	7.200	138.4 1883 T.	.013	NOTE 1
				MOTOR BODY HARDNESS - 286/302 BHN.					
17	570	400	.022	-	6.130	6.600	127 2010 T.	.0135	
				MOTOR BODY HARDNESS - 286 BHN.					
18	570	400	.022	-	6.120	6.100	117.3 2127 T.	.014	

**NOTES:**

1. Slight build-up on flank edge.

**TABLE 98: DATA FOR LIFE LINES**

**Material:** 4340

**Coolant:** TRIM-SOL 20:1

### Tool Description:

**Holder:** CTANR-164

**Insert:** TNMG-4 33E48

[illegible]

**NOTES:**

1. Slight build-up on flank edge.

**TABLE 99: DATA FOR LIFE LINES**



<b>Date:</b> 10/8/81				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 241 BHN.					
25	570	400	.022	-	6.140	5.700	109.9 2896 T.	.016	
				MOTOR BODY HARDNESS - 255/269 BHN.					
26	570	400	.022	-	6.118	5.700	109.6 3006 T.	.0165	
				MOTOR BODY HARDNESS - 255/269 BHN.					
27	570	400	.022	-	6.083	5.300	101.3 3107 T.	.017	
				MOTOR BODY HARDNESS - 241 BHN.					
28	570	400	.022	-	6.130	5.300	102 3209 T.	.0175	
				MOTOR BODY HARDNESS - 255 BHN.					
29	570	400	.022	-	6.202	5.500	107.2 3316 T.	.0175	
				MOTOR BODY HARDNESS - 255 BHN.					
30	570	400	.022	-	6.097	5.300	101.5 3418 T.	.018	

NOTES:

**TABLE 100: DATA FOR LIFE LINES**

<b>Date:</b> 10/9/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS	- 255/269	BHN.			
31	570	400	.022	-	6.132	5.600	107.9 3526 T.	.018	NOTE 1
				MOTOR BODY HARDNESS	- 255	BHN.			
32	570	400	.022	-	6.100	5.700	109 3635 T.	.0185	
				MOTOR BODY HARDNESS	- 235/241	BHN.			
33	570	400	.022	-	6.119	5.900	113.4 3748 T.	.019	
				MOTOR BODY HARDNESS	- 241/255	BHN.			
34	570	400	.022	-	6.111	5.300	101.8 3850 T.	.0195	
				MOTOR BODY HARDNESS	- 255/269	BHN.			
35	570	400	.022	-	6.142	5.400	104.2 3954 T.	.0195	
				MOTOR BODY HARDNESS	- 241/255	BHN.			
36	570	400	.022	-	6.133	5.700	109.8 4064 T.	.020	

**NOTES:**

1. Chip condition for 3" to 4" of turn - 1/4" diameter curl, 1" to 1½" long.

**TABLE 101: DATA FOR LIFE LINES**



<b>Date:</b> 10/13/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 228/241	BHN.			
1	G-30	700	.015	-	6.067	6.300	120	.0045 W .002 F	NOTE 1
				MOTOR BODY	HARDNESS - 255/269	BHN.			
2	G-30	700	.015	-	6.155	5.900	114 234 T.	.0045 W .0025 F	NOTE 2
				MOTOR BODY	HARDNESS - 269	BHN.			
3	G-30	700	.015	-	6.088	5.800	111 345 T.	.0065 W .003 F	
				MOTOR BODY	HARDNESS - 255	BHN.			NOTE 3
4	G-30	700	.015	-	6.078	6.100	116.5 462 T.	.0065 W .004 F	
				MOTOR BODY	HARDNESS - 255	BHN.			
5	G-30	700	.015	-	6.122	5.700	109.6 572 T.	.007 W .005 F	
				MOTOR BODY	HARDNESS - 255	BHN.			
6	G-30	700	.015	-	6.149	5.90	114 686 T.	.007 W. .0055 F	NOTE 3

**NOTES:**

- W - Wear-Land at "Edge of Work" area.  
F - Wear-Land on flange.
- Chips - 1/2" Diam. roll - 4"to 10" long
- Chips - 1/2" Diam. roll - 3"to 6" long

**TABLE 103: DATA FOR LIFE LINES**

<b>Date:</b>	10/13/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							MOTOR BODY HARDNESS - 241/255 BHN.		
7	G-30	700	.015	-	6.090	6.200	118.6 805 T.	.008 W .006 F	NOTE 1
							MOTOR BODY HARDNESS - 241/255 BHN.		
8	G-30	700	.015	-	6.175	5.900	114 920 T.	.008 W .006 F	NOTE 2
							MOTOR BODY HARDNESS - 255/269 BHN.		
9	G-30	700	.015	-	6.125	5.900	113.5 1034 T.	.009 W .0065 F	NOTE 2
							MOTOR BODY HARDNESS - 255 BHN.		
10	G-30	700	.015	-	6.136	5.700	109.8 1144 T.	.009 W .0065 F	NOTE 2 NOTE 3
							MOTOR BODY HARDNESS - 228/241 BHN.		
11	G-30	700	.015	-	6.110	6.000	115.2 1259 T.	.009 W .007 F	NOTE 2
							MOTOR BODY HARDNESS - 241/255 BHN.		
12	G-30	700	.015	-	6.115	6.000	115 1374 T.	.0095 W .0075 F	NOTE 3

**NOTES:**

1. Chip 1/2" Diam. Curl - 3" to 18" long
2. Chip - 1/2" Diam. Curl - 3" to 7" long
3. Slight Chipping at "Edge of Work" area and junction of flank and chamfer

**TABLE 104: DATA FOR LIFE LINES**

<b>Date:</b> 10/3/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 228 BHN.				
13	G-30	700	.015	-	6.097	5.700	109.2 1483 T.	.0095W .0075F	
				MOTOR BODY	HARDNESS - 241 BHN.				
14	G-30	700	.015	-	6.147	5.700	110 1593 T.	.011 .008	NOTE 1
				MOTOR BODY	HARDNESS - 241 BHN.				
15	G-30	700	.015	-	6.080	5.900	112.7 1706 T.	.011 .0085	
				MOTOR BODY	HARDNESS - 241/255 BHN.				
16	G-30	700	.015	-	6.086	5.900	112.8 1819 T.	.0115 .009	
				MOTOR BODY	HARDNESS - 255/269 BHN.				
17	G-30	700	.015	-	6.075	6.000	114.5 1934 T.	.0135 .009	
				MOTOR BODY	HARDNESS - 255 BHN.				
18	G-30	700	.015	-	6.093	5.600	107.2 2041 T.	.0125 .0095	

**NOTES:**

1. Chip 1/2" to 3/4" Dia. Curl - 2" to 7" long

**TABLE 105: DATA FOR LIFE LINES**



<b>Date:</b> 10/13/81				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> NONE					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> NONE				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 241/255	BHN.			
19	G-30	700	.015	-	6.074	5.900	112.6 2154 T.	.013W .010F	
				MOTOR BODY	HARDNESS - 241	BHN.			
20	G-30	700	.015	-	6.062	6.000	114 2268 T.	.013W .010F	
		DATE 10/15/81	-	MOTOR BODY	HARDNESS - 241/255	BHN.			
21	G-30	700	.015	-	6.026	5.900	111.7 2380 T.	.014W .0105F	
				MOTOR BODY	HARDNESS - 255	BHN.			
22	G-30	700	.015	-	6.130	5.900	113.6 2494 T.	.014W .0105F	
				MOTOR BODY	HARDNESS - 241/255	BHN.			
23	G-30	700	.015	-	6.148	5.600	108.2 2602 T.	.014W .011F	
				MOTOR BODY	HARDNESS - 255	BHN.			
24	G-30	700	.015	-	6.119	5.600	107.7 2710 T.	.0145W .0115F	

NOTES:

TABLE 106: DATA FOR LIFE LINES

<b>Date:</b> 10/15/81				<b>Material:</b> 4340			
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> NONE			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> NONE				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-454-820			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS - 269 BHN.				
25	G-30	700	.015	-	6.129	5.800	111.7 2822 T.	.015 W .0115 F	
				MOTOR BODY	HARDNESS - 228 BHN.				
26	G-30	700	.015	-	6.117	6.000	115.3 2937 T.	.0155 W .0115 F	
				MOTOR BODY	HARDNESS - 269/286 BHN.				
27	G-30	700	.015	-	6.115	5.600	107.6 3045 T.	.0155 W .0115 F	
				MOTOR BODY	HARDNESS - 241 BHN.				
28	G-30	700	.015	-	6.073	5.400	103 3148 T.	.0155 W .0115 F	
				MOTOR BODY	HARDNESS - 241 BHN.				
29	G-30	700	.015	-	6.047	6.200	117.8 3266 T.	.016 W .012 F	
				MOTOR BODY	HARDNESS - 241 BHN.				
30	G-30	700	.015	-	6.037	5.200	98.6 3365 T.	.0165 W .0125 F	

**NOTES:**

**TABLE 107: DATA FOR LIFE LINES**



<b>Date:</b>	10/15/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	- 255/269 BHN.			
1	G-30	700	.015	-	6.126	5.700	109.7 .004W .000F		
				MOTOR BODY	HARDNESS	- 241 BHN.			
2	G-30	700	.015	-	6.116	5.600	107.6 218 T. .008W .0025F		
				MOTOR BODY	HARDNESS	- 255 BHN.			
3	G-30	700	.015	-	6.061	5.800	110.4 328 T. .007W .003F		
				MOTOR BODY	HARDNESS	- 255 BHN.			
4	G-30	700	.015	-	6.093	5.700	109.1 437 T. .007W .0035F		
				MOTOR BODY	HARDNESS	- 241 BHN.			
5	G-30	700	.015	-	6.149	6.100	117.8 555 T. .007W .0045F		
				MOTOR BODY	HARDNESS	- 241/255 BHN.			
6	G-30	700	.015	-	6.116	5.600	107.6 663 T. .0065W .0045F		NOTE 1

**NOTES:**

1. "Cracks" ? appear on land above wear-land.

**TABLE 109: DATA FOR LIFE LINES**

<b>Date:</b> 10/15/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	— 241 BHN.			
7	G-30	700	.015	—	6.096	5.900	113 776 T.	.008W .0055F	
				MOTOR BODY	HARDNESS	— 255 BHN.			
8	G-30	700	.015	—	6.136	5.700	109.9 886 T.	.009W .006F	
				MOTOR BODY	HARDNESS	— 241 BHN.			
9	G-30	700	.015	—	6.034	7.000	132.7 1019 T.	.0095W .006F	
				MOTOR BODY	HARDNESS	— 228/241 BHN.			
10	G-30	700	.015	—	6.051	6.100	116 1251 T.	.0095W .0065F	
				DATE 10/16/81 MOTOR BODY	HARDNESS	— 255 BHN.			
11	G-30	700	.015	—	6.110	5.900	113.3 1364 T.	.0105W .007F	
				MOTOR BODY	HARDNESS	— 255 BHN.			
12	G-30	700	.015	—	6.097	5.700	109.2 1473 T.	.0105W .0075F	

**NOTES:**

**TABLE 110: DATA FOR LIFE LINES**

<b>Date:</b>	10/16/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	— 228 BHN.			
13	G-30	700	.015	—	6.073	6.200	118.3 1591 T.	.011W .0075F	NOTE 1
				MOTOR BODY	HARDNESS	— 241/255 BHN.			
14	G-30	700	.015	—	6.035	5.800	110 1701 T.	.0115W .008F	
				MOTOR BODY	HARDNESS	— 241 BHN.			
15	G-30	700	.015	—	6.145	5.800	112 1813 T.	.0115W .008F	
				MOTOR BODY	HARDNESS	— 228 BHN.			
16	G-30	700	.015	—	6.068	5.700	108.7 1922 T.	.0115W .008F	
				MOTOR BODY	HARDNESS	— 241 BHN.			
17	G-30	700	.015	—	6.123	6.000	115.4 2037 T.	.0125W .0085F	
				MOTOR BODY	HARDNESS	— 255 BHN.			
18	G-30	700	.015	—	6.055	6.000	114 2151 T.	.0124W .009F	

**NOTES:**

1. Slight "chatter" on turned surface

**TABLE 111: DATA FOR LIFE LINES**



<b>Date:</b>	10/19/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
19	G-30	700	.015	-	6.099	5.700	109.2 2260 T.	.0135W .009	
20	G-30	700	.015	-	6.106	5.900	113.2 2373 T.	.0135W .0095F	
	DATE	10/21/81							
21	G-30	700	.015	-	6.061	5.900	112.3 2485 T.	.014W .010F	
22	G-30	700	.015	-	6.085	6.000	114.7 2600 T.	.0145W .010F	
23	G-30	700	.015	-	6.123	6.000	115.4 2715 T.	.0145W .0105F	
24	G-30	700	.015	-	6.102	5.400	103.5 2819 T.	.015W .0105F	

NOTES:

TABLE 112: DATA FOR LIFE LINES

<b>Date:</b>	10/21/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	- 241/255	BHN.		
25	G-30	700	.015	-	6.172	5.600	108.6 2928 T.	.015W .0105F	
				MOTOR BODY	HARDNESS	- 255	BHN.		
26	G-30	700	.015	-	-	-	-	SEE NOTE	1
				MOTOR BODY	HARDNESS	- 255	BHN.		
1	G-30	1000	.015	-	6.070	6.000	95.3	.004W .0035F	
				MOTOR BODY	HARDNESS	- 241	BHN.		
2	G-30	1000	.015	-	6.095	5.500	105.3 201 T.	.0055W .004F	
				MOTOR BODY	HARDNESS	241/255	BHN.		
3	G-30	1000	.015	-	6.057	5.800	110.4 311 T.	.006W .0045F	
				MOTOR BODY	HARDNESS	- 241	BHN.		
4	G-30	1000	.015	-	6.090	5.600	107 418 T.	.008W .005F	

**NOTES:**

1. Tool broke after approximately 1" of cut - bad out-of-round condition - diameter did not "clean up" all around part.

**TABLE 113: DATA FOR LIFE LINES**



<b>Date:</b> 10/21/81	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .100"	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
					MOTOR BODY	HARDNESS - 241/255	BHN.		
1	G-30	750	.022	-	6.100	6.000	115	.003 W .000 F	NOTE 1
					MOTOR BODY	HARDNESS - 241	BHN.		
2	G-30	750	.022	-	6.057	5.600	106.6 W 222 T	.007 W .003 F	NOTE 1
					MOTOR BODY	HARDNESS - 241/255	BHN.		
3	G-30	750	.022	-	6.081	5.900	112.7 W 335 T	.0055 W .0035 F	NOTE 1
					MOTOR BODY	HARDNESS - 241/255	BHN.		
4	G-30	750	.022	-	6.071	5.900	112.5 W 448 T	.006 W .0035 F	NOTE 2
					MOTOR BODY	HARDNESS - 228/241	BHN.		
1	G-30	700	.022	-	6.128	6.000	115.5	.003 W .000 F	
					MOTOR BODY	HARDNESS - 255	BHN.		
2	G-30	700	.022	-	6.098	5.200	99.6 W 215 T	.005 W .002 F	

**NOTES:**  
 1 - Chatter Finish.  
 2 - Bad chip in chamfer in "edge of work" area.

**TABLE 115: DATA FOR LIFE LINES**

<b>Date:</b> 10/21/81		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .100"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454 820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 241 BHN.					
3	G-30	700	.022	-	6.070	5.600	106.8 322 T.	.0055 W .002 F	
				MOTOR BODY HARDNESS - 228/241 BHN.					
4	G-30	700	.022	-	6.106	5.300	101.7 424 T.	.007 .003	
				DATE 10/22/81 MOTOR BODY HARDNESS - 241/255 BHN.					
5	G-30	700	.022	-	6.102	5.900	113.1 537 T.	.009 .004	NOTE 1
				MOTOR BODY HARDNESS - 241 BHN.					
6	G-30	700	.022	-	6.118	5.500	105.7 643 T.	.010 .004	
				MOTOR BODY HARDNESS - 241 BHN.					
7	G-30	700	.022	-	6.105	5.500	105.5 748 T.	.010 .0045	
				MOTOR BODY HARDNESS - 241/255 BHN.					
8	G-30	700	.022	-	6.080	5.800	110.8 859 T.	.011 .0045	

**NOTES:**

1 - Small "nick" in chamfer 1/4" from radius - not in cutting area.

**TABLE 116: DATA FOR LIFE LINES**





<b>Date:</b>		10/23/81		<b>Material:</b>		4340	
<b>Depth of Cut:</b>		APPROX. .100		<b>Coolant:</b>		TRIM-SOL 20:1	
<b>Hardness:</b>		SEE TAB		<b>Tool Description:</b>			
<b>Coolant Application:</b>		TOP		<b>Holder:</b>		CCGNR-164	
				<b>Insert:</b>		CNG-454 820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS — 241 BHN.					
1	G-10	800	.015	-	6.056	6.000	114.2	.002 W .001 F	
				MOTOR BODY HARDNESS — 228/241 BHN.					
2	G-10	800	.015	-	6.050	5.600	106.4 221 T.	.0035 W .003 F	
				MOTOR BODY HARDNESS — 241/255 BHN.					
3	G-10	800	.015	-	6.113	5.800	111.4 332.4 T.	.0035 W .0035 F	
				MOTOR BODY HARDNESS — 241/255 BHN.					
4	G-10	800	.015	-	6.025	5.700	107.9 440 T.	.0045 W .004 F	NOTE 1
				MOTOR BODY HARDNESS — 228/241 BHN.					
5	G-10	800	.015	-	6.097	5.800	111 551 T.	.0055 W .005 F	
				MOTOR BODY HARDNESS — 241 BHN.					
6	G-10	800	.015	-	6.073	5.700	108.7 660 T.	.007 W .006 F	

**NOTES:**  
1 - May have crack leading from intersection of nose radius and flank to rear of tool.

**TABLE 118: DATA FOR LIFE LINES**

<b>Date:</b> 10/23/81				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454 820					
<b>RUN NO.</b>	<b>CARBIDE GRADE</b>	<b>CUTTING SPEED-FT/MIN.</b>	<b>FEED IN./REV.</b>	<b>ROUGH DIAMETER</b>	<b>TURNED DIAMETER</b>	<b>TURNED LENGTH</b>	<b>MACHINED AREA — IN<sup>2</sup></b>	<b>WEAR-LAND INCH</b>	<b>IN<sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND</b>
				MOTOR BODY	HARDNESS - 241/255	BHN.			
7	G-10	800	.015	-	6.067	5.700	108.6 769 T.	.007 W .006 F	
				MOTOR BODY	HARDNESS - 228	BHN.			
8	G-10	800	.015	-	6.105	5.400	103.5 873 T.	.008 W .007 F	
				MOTOR BODY	HARDNESS - 241/255	BHN.			
9	G-10	800	.015	-	6.055	5.700	108.4 981 T.	.008 W .0075 F	
DATE 10/26/81				MOTOR BODY	HARDNESS - 241	BHN.			
10	G-10	800	.015	-	6.100	6.000	115 1096 T.	.008 .0085	
				MOTOR BODY	HARDNESS - 241	BHN.			
11	G-10	800	.015	-	6.110	5.700	109.4 1205 T.	.010 .009	
				MOTOR BODY	HARDNESS - 255	BHN.			
12	G-10	800	.015	-	6.042	5.600	106.3 1311 T.	.0105 .0095	
<b>NOTES:</b>									

TABLE 119: DATA FOR LIFE LINES

<b>Date:</b>	10/26/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454 820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY	HARDNESS	- 228/241	BHN.		
13	G-10	800	.015	-	6.122	5.700	109.6 1421 T.	.0105 W .0010 F	
				MOTOR BODY	HARDNESS	- 228/241	BHN.		
14	G-10	800	.015	-	6.083	5.800	110.8 1532 T.	.011 W .0105 F	
				MOTOR BODY	HARDNESS	- 241	BHN.		
15	G-10	800	.015	-	6.058	5.600	106.6 1639 T.	.012 W .011 F	
				MOTOR BODY	HARDNESS	- 241/255	BHN.		
16	G-10	800	.015	-	6.095	5.600	107.2 1746 T.	.0125 W .0115 F	NOTE 1
				MOTOR BODY	HARDNESS	- 228/241	BHN.		
17	G-10	800	.015	-	6.064	5.900	112.4 1858 T.	.013 W .012 F	
				MOTOR BODY	HARDNESS	- 241	BHN.		
18	G-10	800	.015	-	6.094	5.500	105.3 1963 T.	.014 F	NOTE 2

**NOTES:**

- 1 - Small "nick" in chamfer at junction of nose radius and leading flank.
- 2 - Failure at "edge of work" area, but nose radius still intact.

**TABLE 120: DATA FOR LIFE LINES**

<b>Date:</b>	10/26/81	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS	-	241 BHN		
1	G-10	1000	.015	-	6.061	6.000	114.2	.0025 W .002 F	
				MOTOR	BODY HARDNESS	-	241 BHN		
2	G-10	1000	.015	-	6.101	5.500	105.4 220 T.	.004 W .0035 F	
				MOTOR	BODY HARDNESS	-	241 BHN		
3	G-10	1000	.015	-	6.052	5.900	112.1 332 T.	.0055 W .005 F	
				MOTOR	BODY HARDNESS	-	241 BHN		
4	G-10	1000	.015	-	6.099	5.700	109.2 441 T.	.007 W .0065 F	

**NOTES:**

W - Wear land at "edge of work" area.  
F - Wear land on flank.

**TABLE 121: DATA FOR LIFE LINES**

**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 4340

**HARDNESS:** 241 BHN (3 PARTS)

**INSERT:** TNMG-433  
E-48

**SURFACE FEED:** 400

**COOLANT:** TRIM-SOL  
20:1

**GRADE:** 570

**FEEDRATE:** .022 IN./REV. TOP APPLICATION

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	360	140	190
.100	720	290	220
.150	1060	480	290
.200	1400	640	360

**INSERT:** CNG-454  
820

**SURFACE FEED:** 800

**COOLANT:** TRIM-SOL  
20:1

**GRADE:** G-10

**FEEDRATE:** .015 IN./REV. TOP APPLICATION

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	260	100	150
.100	520	240	190
.150	760	370	220
.200	1000	500	250

**INSERT:** CNG-454  
820

**SURFACE FEED:** 700

**COOLANT:** NONE

**GRADE:** G-30

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	280	120	150
.100	540	260	190
.150	800	380	220
.200	1050	540	250

**TABLE 122: DATA FOR TOOL LOAD CHARTS**

## TOOL LOAD VERSUS DEPTH OF CUT

**Material:** 4340

**Holder:** CTANR-164

**Hardness:** 241 BHN.

**Insert:** TNMG-433E48

**Feed Rate:** .022 IN./REV.

**Grade:** 570

**Surface Speed:** 400 FT./MIN.

**Coolant:** TRIM-SOL 20:1 TOP

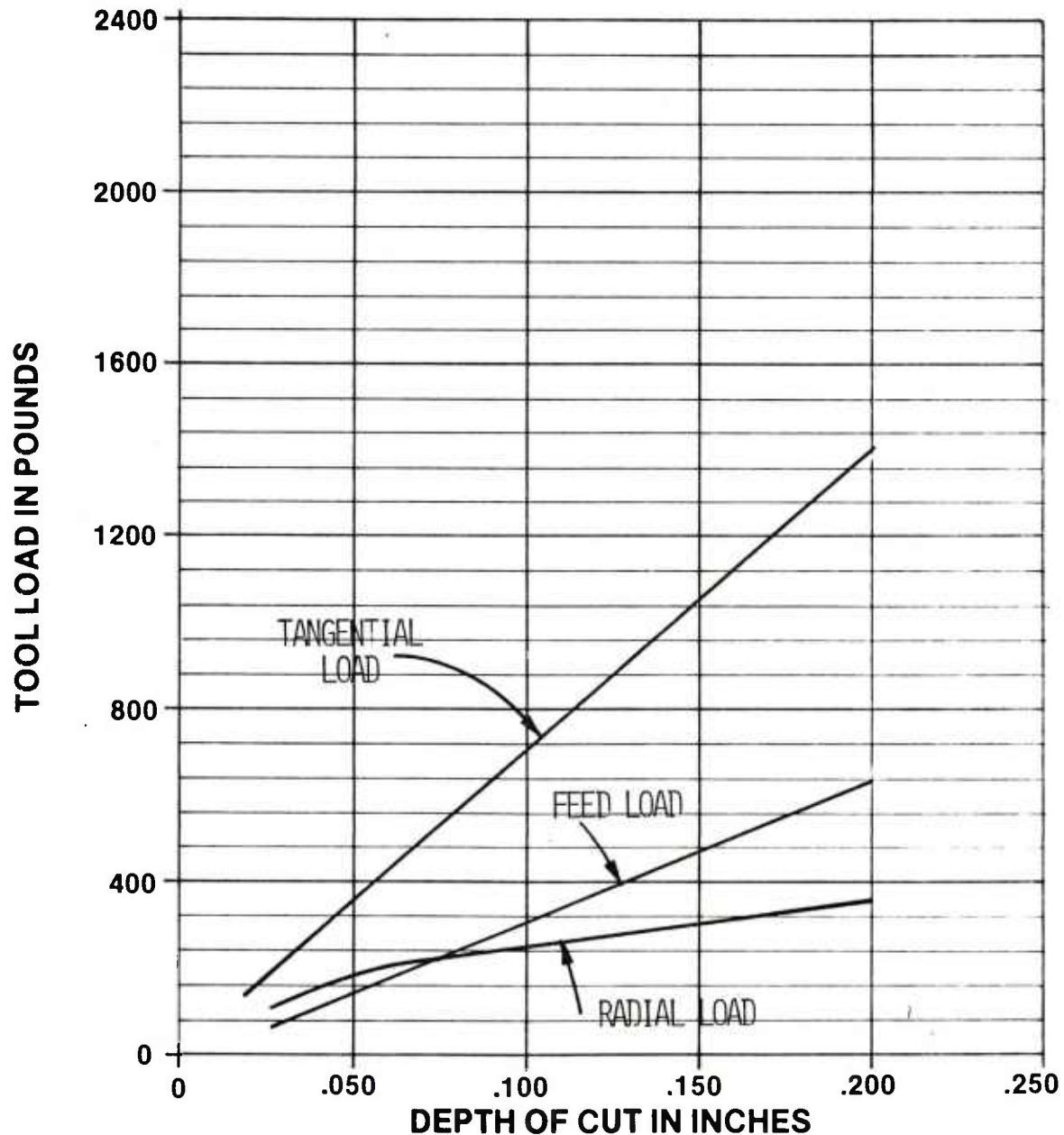


FIGURE 48: TOOL LOAD CHART



## TOOL LOAD VERSUS DEPTH OF CUT

**Material:** 4340

**Holder:** CCGNR-164

**Hardness:** 241 BHN

**Insert:** CNG-454-820

**Feed Rate:** .015 IN./REV.

**Grade:** G-10

**Surface Speed:** 800 FT./MIN.

**Coolant:** TRIM-SOL 20:1 TOP

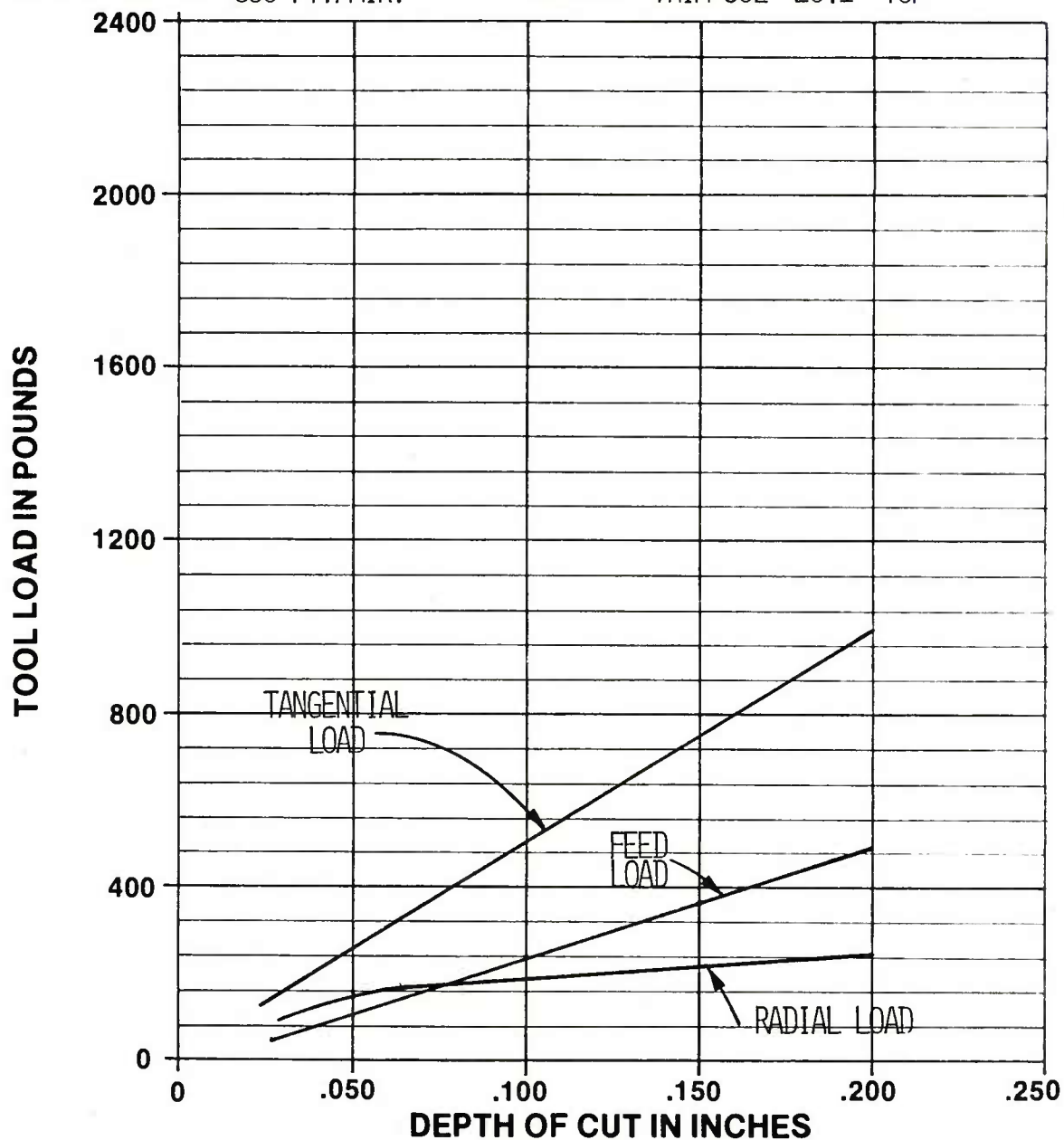


FIGURE 49: TOOL LOAD CHART

## TOOL LOAD VERSUS DEPTH OF CUT

**Material:** 4340

**Holder:** CCGNR-164

**Hardness:** 241 BHN.

**Insert:** CNG-454-820

**Feed Rate:** .015 IN./REV.

**Grade:** G-30

**Surface Speed:** 700 FT./MIN.

**Coolant:** NONE

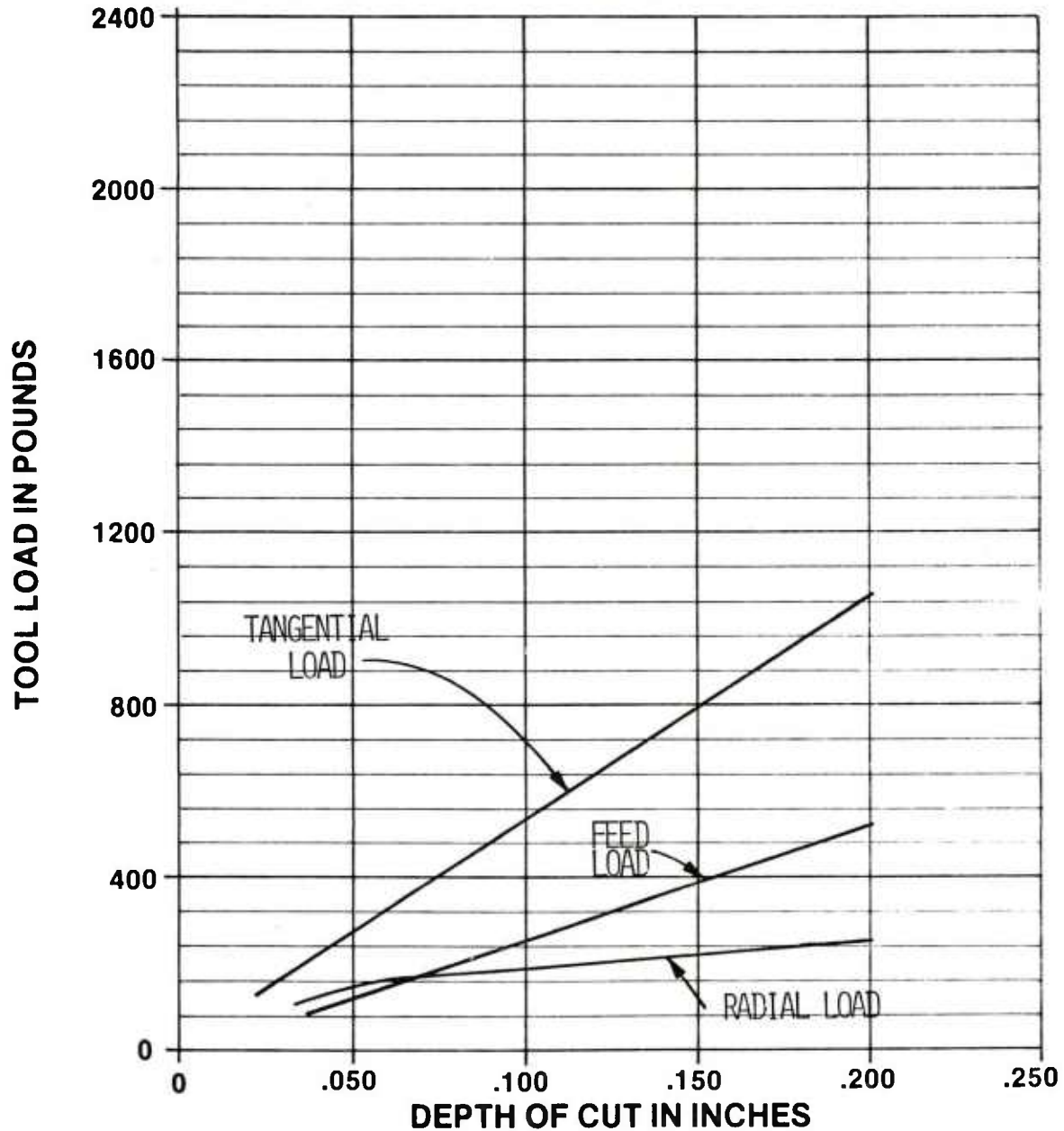


FIGURE 50: TOOL LOAD CHART

<b>Date:</b> 2/15/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b>
<b>Hardness:</b> SEE FIGURE	<b>Tool Description:</b>
<b>Coolant Application:</b>	<b>Holder:</b> SEE FIGURE
	<b>Insert:</b> SEE FIGURE

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				LIFE-LINE DATA		FROM TEST			
	570	300	.015	-	-	-	-	-	2600   .012
	570	325	.015	-	-	-	-	-	1200   .012
	570	350	.015	-	-	-	-	-	700   .012
	570	450	.015	-	-	-	-	-	188   .012
				LIFE-LINE DATA		FROM TEST			
	NTK	300	.011	-	-	-	-	-	1050   .012
	NTK	350	.011	-	-	-	-	-	625   .012
	NTK	400	.011	-	-	-	-	-	420   .012
	NTK	500	.011	-	-	-	-	-	250   .012
	NTK	550	.011	-	-	-	-	-	207   .012

**NOTES:**

**TABLE 123: DATA FOR LIFE LINES**

<b>Date:</b> 1/18/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMC-433-E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	570	350	.015	-	6.012	5.500	103.8	.008	
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	570	350	.015	-	6.029	5.000	94.7 199 T.	.0085	
				MOTOR BODY HARDNESS - 388/415 BHN.					
3	570	350	.015	-	6.026	6.900	130.6 330 T.	.0095	
				MOTOR BODY HARDNESS - 363/388 BHN.					
4	570	350	.015	-	5.991	6.500	122.3 452 T.	.0105	
				MOTOR BODY HARDNESS - 388/415 BHN.					
5	570	350	.015	-	6.035	5.000	94.8 547 T.	.011	NOTE 1
				MOTOR BODY HARDNESS - 388/415 BHN.					
6	570	350	.015	-	6.049	6.500	123.5 671 T.	.0115	

**NOTES:**  
 1 - Chip-condition 1/2" to 3/4" diameter roll, 8" to 12" long.

**TABLE 124: DATA FOR LIFE LINES**

<b>Date:</b> 1/18/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433-E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388 BHN.					
7	570	350	.015	-	6.031	5.500	104.2 775 T.	.014	NOTE 1
				MOTOR BODY HARDNESS - 388 BHN.					
8	570	350	.015	-	6.006	5.200	98.1 873 T.	.0175	
NEW INSERT				MOTOR BODY HARDNESS - 388/415 BHN.					
1	570	300	.015	-	5.959	5.700	106.7	.0055	
				MOTOR BODY HARDNESS - 388 BHN.					
2	570	300	.015	-	6.049	5.400	102.6 209 T.	.007	NOTE 2
				MOTOR BODY HARDNESS - 388/415 BHN.					
3	570	300	.015	-	6.007	5.500	103.8 313 T.	.008	
				MOTOR BODY HARDNESS - 415 BHN.					
4	570	300	.015	-	5.971	5.500	103.2 416 T.	.0085	

**NOTES:**  
  
1 - Chip-condition 1" diameter roll continuous chip.  
2 - Chip-condition 1" diameter roll, 8" to 12" long.

TABLE 125: DATA FOR LIFE LINES

<b>Date:</b> 1/18/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433-E48					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388/415 BHN.					
5	570	300	.015	-	5.990	5.500	103.5 519 T.	.0085	
				MOTOR BODY HARDNESS - 388/415 BHN.					
6	570	300	.015	-	6.007	5.000	94.4 613 T.	.0085	
				MOTOR BODY HARDNESS - 363/388 BHN.					
7	570	300	.015	-	6.022	6.100	115.4 728 T.	.0085	
				MOTOR BODY HARDNESS - 363/388 BHN.					
8	570	300	.015	-	6.015	5.200	98.2 826 T.	.0085	
	1/19/82			MOTOR BODY HARDNESS - 363 BHN.					
9	570	300	.015	-	6.035	5.500	104.3 930 T.	.009	
				MOTOR BODY HARDNESS - 363 BHN.					
10	570	300	.015	-	5.977	5.900	110.8 1041 T.	.009	
<b>NOTES:</b>									

TABLE 126: DATA FOR LIFE LINES



<b>Date:</b> 1/19/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433-E48					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
11	570	300	.015	-	5.995	6.000	113 1154 T.	.0095	NOTE 1
				MOTOR BODY HARDNESS - 363 BHN.					
12	570	300	.015	-	6.081	5.300	101.3 1255 T.	.0095	
				MOTOR BODY HARDNESS - 363/388 BHN.					
13	570	300	.015	-	5.972	5.400	101.3 1356 T.	.0095	
				MOTOR BODY HARDNESS - 363 BHN.					
14	570	300	.015	-	6.026	5.200	98.4 1454 T.	.010	
				MOTOR BODY HARDNESS - 363/388 BHN.					
15	570	300	.015	-	6.009	5.500	103.8 1558 T.	.010	NOTE 2
				MOTOR BODY HARDNESS - 363 BHN.					
16	570	300	.015	-	6.024	6.800	128.7 1687 T.	.010	
<b>NOTES:</b> 1 - Chip-condition - 1/2" diameter roll - 10" long to continuous. 2 - Appears to be a crack in top flank of insert from edge of work area to centerline of nose radius, but has not met edge yet.									

TABLE 127: DATA FOR LIFE LINES

<b>Date:</b>	1/19/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 36B/388 BHN.				
17	570	300	.015	-	6.047	5.000	95 1782 T.	.0105	
				MOTOR	BODY HARDNESS - 36B BHN.				
18	570	300	.015	-	6.005	4.900	92.4 1874 T.	.0105	
				MOTOR	BODY HARDNESS - 36B BHN.				
19	570	300	.015	-	6.022	5.200	98.4 1972 T.	.0105	
				MOTOR	BODY HARDNESS - 36B/388 BHN.				
20	570	300	.015	-	5.997	5.500	103.6 2076 T.	.011	
				MOTOR	BODY HARDNESS - 36B BHN.				
21	570	300	.015	-	6.027	6.000	113.6 2190 T.	.011	
				MOTOR	BODY HARDNESS - 36B/388 BHN.				
22	570	300	.015	-	6.029	5.200	98.5 2288 T.	.011	

**NOTES:**

**TABLE 128: DATA FOR LIFE LINES**

<b>Date:</b> 1/19/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433-E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363 BHN.				
23	570	300	.015	-	5.942	5.700	106.4 2394 T.	.0115	NOTE 1
DATE 1/20/82				MOTOR	BODY HARDNESS - 363 BHN.				
24	570	300	.015	-	6.003	5.200	98. 2492 T.	.012 N.	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
25	570	300	.015	-	6.025	7.100	134.4 2626 T.	.012 F.	
				MOTOR	BODY HARDNESS - 388 BHN.				
26	570	300	.015	-	6.043	5.500	104.4 2730 T.	.013 F. .0140 N.	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
27	570	300	.015	-	6.070	5.500	104.9 2835 T.	.013 F. .014 N.	
				MOTOR	BODY HARDNESS - 363 BHN.				
28	570	300	.015	-	6.010	6.900	130.3 2965 T.	.0145 F. .016 N.	

**NOTES:**

1 - Chip-condition - 1/2" to 1" diameter roll - continuous chip

N - denotes nose wear

F - denotes flank wear

**TABLE 129: DATA FOR LIFE LINES**

<b>Date:</b> 1/20/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433-E48					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388 BHN.					
29	570	300	.015	-	6.001	5.200	98 3063 T.	.0145 F. .0195 N.	
NEW INSERT				MOTOR BODY HARDNESS - 363 BHN.					
1	570	325	.015	-	6.010	5.500	103.8	.008	
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	570	325	.015	-	6.006	6.700	126.4 230 T.	.009	
				MOTOR BODY HARDNESS - 363 BHN.					
3	570	325	.015	-	6.033	5.500	104.2 334 T.	.0095	
				MOTOR BODY HARDNESS - 363/388 BHN.					
4	570	325	.015	-	6.010	7.500	141.6 476 T.	.010	
				MOTOR BODY HARDNESS - 363 BHN.					
5	570	325	.015	-	6.024	7.400	140 616 T.	.010	
<b>NOTES:</b> F - denotes flank wear N - denotes nose wear									

TABLE 130: DATA FOR LIFE LINES

<b>Date:</b>	1/20/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363/388 BHN				
6	570	325	.015	-	6.022	7.500	141.9 758 T.	.010	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
7	570	325	.015	-	5.983	7.200	135.3 893 T.	.011	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
8	570	325	.015	-	5.995	7.700	145 1038 T.	.0115	F.
				MOTOR	BODY HARDNESS - 363 BHN.				
9	570	325	.015	-	6.016	6.000	113.4 1151 T.	.0115	F.
				MOTOR	BODY HARDNESS - 363/388 BHN.				
10	570	325	.015	-	6.041	7.900	149.9 1301 T.	.0125	F.
				MOTOR	BODY HARDNESS - 388 BHN.				
11	570	325	.015	-	6.033	5.500	104.2 1405 T.	.0155	N. NOTE 1

**NOTES:**

1 - Maximum wear land was on nose - but previous reading was equal to flank wear.

**TABLE 131: DATA FOR LIFE LINES**





<b>Date:</b> 1/22/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> CNG-454-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	G-10	700	.015	-	6.010	6.000	113.3	.0025	
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-10	700	.015	-	5.977	7.500	140.8 254 T.	.004	NOTE 1
				MOTOR BODY HARDNESS - 363/388 BHN.					
3	G-10	700	.015	-	6.012	6.400	120.8 375 T.	.006	NOTE 2
				MOTOR BODY HARDNESS - 388/415 BHN.					
1	G-10	550	.015	-	6.018	5.200	98.3	.000	
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-10	550	.015	-	6.022	6.400	121.1 219 T.	.0045 N. .008 R.	
				MOTOR BODY HARDNESS - 388/415 BHN.					
3	G-10	550	.015	-	5.992	7.700	144.9 364 T.	.006 N. .012 R.	

**NOTES:**

1 - .016 wear land notch at rear of nose radius where tool leaves work. Load charts showed radial load of approx. 150 lbs. at end of first cut and 250 lbs. at start of second cut, with no increase during cut.

2 - Radial load was 320 lbs. - third run .020" notch wear - cut stopped.

**TABLE 133: DATA FOR LIFE LINES**

<b>Date:</b> 1/22/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	G-10	750	.011	-	6.002	7.400	139.5	.0035	NOTE 1
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	G-10	750	.011	-	6.028	6.000	113.6 253 T.	.0075	
				MOTOR BODY HARDNESS - 388 BHN.					
3	G-10	750	.011	-	6.000	5.700	107.4 360 T.	.0105	NOTE 2
				MOTOR BODY HARDNESS - 388 BHN.					
1	G-10	650	.011	-	6.022	5.300	100.3	.002	
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-10	650	.011	-	6.020	6.000	130.5 231 T.	.0075	NOTE 3
				MOTOR BODY HARDNESS - 388/415 BHN.					
DATE 1/25/82									
1	G-10	450	.015	-	6.006	7.700	145.2	.0035	.012 N.R.

**NOTES:** 1 - slight chip in chamfer at "edge of work" area.  
2 - chip in leading edge chipped out - nose radius still good - vertical and feed loads increased at end of cut.  
3 - lowering feed did not change rate of wear enough to warrant change.

**TABLE 134: DATA FOR LIFE LINES**

<b>Date:</b> 1/25/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-10	450	.015	-	6.059	5.600	106.6 252 T.	.004	Note 1 .012
				MOTOR BODY HARDNESS - 363 BHN.					
3	G-10	450	.015	-	6.004	6.900	130.1 382 T.	.0045	.015 (1)
				MOTOR BODY HARDNESS - 388 BHN.					
4	G-10	450	.015	-	5.969	5.800	108.7 491 T.	.005	.016 (1)
				MOTOR BODY HARDNESS - 363/388 BHN.					
5	G-10	450	.015	-	6.038	5.800	110 601 T.	.006	.018 (1)
				MOTOR BODY HARDNESS - 363 BHN.					
6	G-10	450	.015	-	5.940	6.900	128.7 730 T.	.0065	.020 (1)
				MOTOR BODY HARDNESS - 363/388 BHN.					
7	G-10	450	.015	-	5.960	6.200	116 846 T.	.007	.021 (1)

**NOTES:**  
1 - wear land at junction of nose radius and end cutting edge angle.

TABLE 135: DATA FOR LIFE LINES

<b>Date:</b> 1/25/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 36B/388 BHN.				
8	G-10	450	.015	-	6.000	5.900	111.2 957 T.	.008	NOTE 1 .024
				MOTOR	BODY HARDNESS - 36B BHN.				
9	G-10	450	.015	-	6.017	6.400	120.9 1078 T.	.008	.024 (1)
				MOTOR	BODY HARDNESS - 38B/415 BHN.				
10	G-10	450	.015	-	6.016	6.000	113.3 1191 T.	.009	.026 (1)
				MOTOR	BODY HARDNESS - 38B/415 BHN.				
11	G-10	450	.015	-	6.033	2.000	-	-	NOTE 2

**NOTES:** NOTE 1 - area previously called wear-land looks like build-up and the rubbing on the work-piece gives the appearance of wear.  
2 - leading edge of insert broke out at "edge of work" area - insert inspected and area at rear of nose radius was wear - but did not cause breakage.

TABLE 136: DATA FOR LIFE LINES

<b>Date:</b>	1/25/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388/415 BHN.					
1	G-30	450	.015	-	6.033	4.000	76		
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	G-30	450	.015	-	6.029	5.500	104.2 180 T.	.003	
				MOTOR BODY HARDNESS - 363/388 BHN.					
3	G-30	450	.015	-	6.030	5.900	111.8 292 T.	.003	NOTE 1 .012
				MOTOR BODY HARDNESS - 388/415 BHN.					
4	G-30	450	.015	-	6.032	5.500	104.2 396 T.	.004	.015 (1)
				MOTOR BODY HARDNESS - 363/388 BHN.					
5	G-30	450	.015	-	6.019	7.300	138. 534 T.	.005	.017 (1)
				MOTOR BODY HARDNESS - 388/415 BHN.					
6	G-30	450	.015	-	6.002	6.100	115 649 T.	.0055	.020 (1)

**NOTES:**

1 - wear land at junction of nose radius and end cutting edge angle.

**TABLE 137: DATA FOR LIFE LINES**





<b>Date:</b>	1/27/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164 (NOTE 1)
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
1	G-10	450	.015	-	6.031	5.400	102.3	.002F	NOTE 2
				MOTOR	BODY HARDNESS - 363/388 BHN.				
2	G-10	450	.015	-	6.054	5.900	112.2 215 T.	.0025	.010 (3)
				MOTOR	BODY HARDNESS - 388 BHN.				
3	G-10	450	.015	-	6.008	5.600	105.7 321 T.	.0035	.015 (3)
				MOTOR	BODY HARDNESS - 363 BHN.				
4	G-10	450	.015	-	6.021	6.500	122.9 444 T.	.004	.016 (3)
				MOTOR	BODY HARDNESS - 388 BHN.				
5	G-10	450	.015	-	6.070	6.700	127.8 572 T.	.005	.017 (3)
				MOTOR	BODY HARDNESS - 388 BHN.				
6	G-10	450	.015	-	6.012	9.200	173.7 746 T.	.005	.018 (3)

**NOTES:** 1 - Holder machined to have  $1\frac{1}{2}^{\circ}$  add. back rake.  
2 - radial loads decreased approx. 100 lbs. compared with previous tests using same cutting conditions and material hardness - no wear at end of nose radius.  
3 - wear at junction of nose radius and end cutting edge angle.

**TABLE 139: DATA FOR LIFE LINES**

<b>Date:</b> 1/27/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b> (NOTE	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164 1)	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
1	G-10	450	.015	-	6.046	5.500	104.5	.001+	
				MOTOR	BODY HARDNESS - 363 BHN.				
2	G-10	450	.015	-	6.005	7.800	147.1 252 T.	.005 N .0035 F	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
3	G-10	450	.015	-	5.965	7.300	136.8 389 T.	.008 N .004 F	
				MOTOR	BODY HARDNESS - 415 BHN.				
4	G-10	450	.015	-	5.981	6.900	129.6 519 T.	.008 N .005 F	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
5	G-10	450	.015	-	6.024	5.400	102.2 62 T.	.010 N .0055 F	
				MOTOR	BODY HARDNESS - 388/415 BHN.				
6	G-10	450	.015	-	5.987	7.200	135.4 756 T.	.010 N .0055 F	

**NOTES:** 1 - Holder machined to have 5° position lead angle and had 1½° add. back rake.

"N" wear land at junction of nose radius and end cutting edge angle.

"F" wear on flank and nose radius.

TABLE 140: DATA FOR LIFE LINES

<b>Date:</b> 1/28/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164 (NOTE 1)					
				<b>Insert:</b> CNG 452 630					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	G-10	450	.015	-	6.025	6.500	123	.002 F.	
				MOTOR	BODY HARDNESS - 388 BHN.				
2	G-10	450	.015	-	6.036	6.300	119.4 242 T.	.004 N .004 F.	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
3	G-10	450	.015	-	6.032	7.700	145.9 388 T.	.008 N .005 F.	
				MOTOR	BODY HARDNESS - 363 BHN.				
4	G-10	450	.015	-	5.968	5.600	104.9 493 T.	.008 N .006 F.	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
5	G-10	450	.015	-	5.976	5.000	93.8 587 T.	.010 N .0065 F.	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
6	G-10	450	.015	-	6.002	5.500	103.7 691 T.	.010 N .007 F.	

**NOTES:** 1 - Holder has 5° lead angle and 6½° back rake.

F - wear land at flank and nose radius.

N - wear land at junction of nose radius and end cutting edge angle.

**TABLE 141: DATA FOR LIFE LINES**

<b>Date:</b> 1/28/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-452-630	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	G-10	450	.015	-	6.022	5.600		.001 F.	
				MOTOR	BODY HARDNESS - 388 BHN.				
2	G-10	450	.015	-	5.993	5.700		.003 F.	NOTE 1
				MOTOR	BODY HARDNESS - 363/388 BHN.				
3	G-10	450	.015	-	5.971	5.700		.004 N. .005 F.	NOTE 2
				MOTOR	BODY HARDNESS - 363/388 BHN.				
4	G-10	450	.015	-	5.997	6.900		.004 N. .010 F.	NOTE 3
				MOTOR	BODY HARDNESS - 363/388 BHN.				
5	G-10	450	.015	-	6.017	6.900		.004 N. .0105 F.	NOTE 3
				MOTOR	BODY HARDNESS - 363/388 BHN.				
6	G-10	450	.015	-	6.032	7.600		.004 .012 F.	

**NOTES:**

1 - some small "chipping" on nose radius.

2 - more chipping on nose radius.

3 - wear land measured as length of chipping on nose radius.

**TABLE 142: DATA FOR LIFE LINES**

<b>Date:</b> 2/3/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-453-630	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363 BHN.					
1	G-10	450	.015	-	6.024	6.200	117.3	.0025N	.000 W.
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-10	450	.015	-	6.006	6.700	126.4 244 T.	.0035N	.004 W.
				MOTOR BODY HARDNESS - 388 BHN.					
3	G-10	450	.015	-	6.120	6.300	121.1 365 T.	.0055N	.005 W.
				MOTOR BODY HARDNESS - 363/388 BHN.					
4	G-10	450	.015	-	6.021	8.900	168.3 533 T.	.006N	.006 W.
				MOTOR BODY HARDNESS - 388 BHN.					
5	G-10	450	.015	-	-	-	-	.020N	NOTE 1

**NOTES:**  
N - wear on nose radius.  
W - wear at junction of nose radius and end cutting edge angle.  
1 - excessive nose wear due to out-of-roundness.

**TABLE 143: DATA FOR LIFE LINES**

<b>Date:</b> 2/3/82				<b>Material:</b> 4340			
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-453-630			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS -			388 BHN.		
1	G-10	400	.015	-	6.003	8.800	166.0	.002	N..007 W.
				MOTOR BODY HARDNESS -			363/388 BHN.		
2	G-10	400	.015	-	6.038	6.500	123.3 289 T.	.004	N..008 W.
				MOTOR BODY HARDNESS -			388 BHN.		
3	G-10	400	.015	-	6.005	8.400	158.4 447 T.	.005	N..011 W.
				MOTOR BODY HARDNESS -			388 BHN.		
4	G-10	400	.015	-	6.004	7.000	132 579 T.	.006	.011 W.
				MOTOR BODY HARDNESS -			388 BHN.		
1	G-10	1000	.011	-	5.998	7.300	137.6	.005	NOTE 1
				MOTOR BODY HARDNESS -			363/388 BHN.		
2	G-10	1000	.011	-	5.986	6.000	112.8 250 T.	.010	375 .015

**NOTES:**  
  
1 - Notch at "edge of work" area.

TABLE 144: DATA FOR LIFE LINES



<b>Date:</b> 2/3/82				<b>Material:</b> 4340			
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-452-630			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	G-10	1000	.011	-	6.005	8.300	156.6	.006	.016 W
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	G-10	1000	.011	-				.008	.016 W 1
	DATE 2/4/82			MOTOR BODY HARDNESS - 363/388 BHN. (NOTE 2)					
1	G-10	1000	.015	-	6.041	1.300	24.7	.016N	23 .015
	NEW CORNER								
1	G-10	800	.015	-	6.041	1.300	24.7		NOTE 3
				MOTOR BODY HARDNESS 363/388 BHN.					
1	G-10	1000	.015	-	5.996	5.900	111.1	.0135N	123 .015
				MOTOR BODY HARDNESS - 388 BHN.					
1	G-10	800	.015	-	6.047	6.000	114.0	.0065N	

**NOTES:**

1 - Test stopped-flank chipped out on tool.

2 - Insert SNG-458-630, holder 30° lead angle.

3 - Part did not "clean up" - test stopped.

**TABLE 145: DATA FOR LIFE LINES**

[illegible]**TABLE 146: DATA FOR LIFE LINES**

<b>Date:</b> 2/4/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-453-630					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363 BHN.					
1	G-10	850	.011	-	5.995	5.800	109.2	.0055N	.016W
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	G-10	850	.011	-	-	2.500	-	NOTE 1	
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	G-10	850	.011	-	6.026	3.000	-	000	NOTE 3
	INSERT CNG-454-820			MOTOR BODY HARDNESS - 388 BHN.					
1	G-30	850	.011	-	6.032	5.500	-	-	NOTE 4

**NOTES:**  
N - wear on nose radius.  
W - wear at junction of nose radius and end cutting edge angle.  
1 - complete nose radius failure.  
2 - coolant shut off.  
3 - chipping on nose radius.  
4 - wear at junction of N. R. and end cutting edge angle.

TABLE 147: DATA FOR LIFE LINES

<b>Date:</b> <u>2/4/82</u>	<b>Material:</b> <u>4340</u>
<b>Depth of Cut:</b> <u>.050</u>	<b>Coolant:</b> <u>NONE</u>
<b>Hardness:</b> <u>SEE TAB</u>	<b>Tool Description:</b> _____
<b>Coolant Application:</b> <u>NONE</u>	<b>Holder:</b> <u>CCGNR-164</u>
	<b>Insert:</b> <u>CNG-442-820</u>

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND	
				MOTOR	BODY HARDNESS - 363 BHN.					
1	G-30	850	.011	-	5.982	5.600	105.2	.004		
				MOTOR	BODY HARDNESS - 363/388 BHN					
2	G-30	850	.011	-	6.021	5.300	100.3 205 T.	.007		
				MOTOR	BODY HARDNESS - 363 BHN.					
3	G-30	850	.011	-	6.012	5.300	100.1 305 T.	.0095		
				MOTOR	BODY HARDNESS 363/388 BHN.					
4	G-30	850	.011	-	6.004	5.700	107.5 413 T.	.0105		
				MOTOR	BODY HARDNESS - 388 BHN.					
5	G-30	850	.011	-	5.979	6.300	118.3 531.3	.0095		
				DATE 2/5/82	MOTOR	BODY HARDNESS - 363/388 BHN.				
6	G-300	850	.011	-	6.069	5.900	112.5 644 T.	.0105		

**NOTES:**

**TABLE 148: DATA FOR LIFE LINES**

<b>Date:</b>	2/5/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-442-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363/388 BHN.				
7	G-30	850	.011	-	6.030	3.400	64.4 708.4 T	-	NOTE 1
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	G-30	700	.011	-	6.030	2.500	47.4	-	-
				MOTOR	BODY HARDNESS - 388 BHN.				
2	G-30	700	.011	-	6.021	5.800	109.7 157 T.	.0045	-
				MOTOR	BODY HARDNESS - 388 BHN.				
3	G-30	700	.011	-	6.004	5.600	105.6 263 T.	.006	.012
				MOTOR	BODY HARDNESS - 363/388 BHN.				
4	G-30	700	.011	-	5.967	4.000	75 338 T.	-	-
				MOTOR	BODY HARDNESS - 388 BHN.				
5	G-30	700	.011	-	5.981	5.900	110.8 449 T.	.009	.016

**NOTES:**

1 - flank of tool broke out - increases noted on dynamometer - test stopped.

**TABLE 149: DATA FOR LIFE LINES**

<b>Date:</b> 2/5/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-442-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							MOTOR BODY HARDNESS - 388 BHN.		
6	G-30	700	.011	-	6.038	5.500	104.3 553 T.	.010	.020
							MOTOR BODY HARDNESS - 363/388 BHN.		
7	G-30	700	.011	-	6.023	5.700	107.8 661 T.	.0115	.020
							MOTOR BODY HARDNESS - 388 BHN.		
8	G-30	700	.011	-	6.016	5.800	109.6 771 T.	.0125	.024
							MOTOR BODY HARDNESS - 388 BHN.		
9	G-30	700	.011	-	6.031	5.300	100.4 871 T.	.0145	.024
							MOTOR BODY HARDNESS - 363/388 BHN.		
10	G-30	700	.011	-	6.035	5.600	106.2 977 T.	.0160	.026

**NOTES:**

**TABLE 150: DATA FOR LIFE LINES**



<b>Date:</b> 2/9/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-442-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
1	G-30	1000	.011	-	6.017	5.300	100.2	.0075	.008
				MOTOR	BODY HARDNESS - 388 BHN.				
2	G-30	1000	.011	-	6.015	5.400	102.0 202 T.	.010	.024
				MOTOR	BODY HARDNESS - 388 BHN.				
3	G-30	1000	.011	-	6.040	5.700	108.1 310 T.	.0145	.024
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	G-30	500	.011	-	6.010	5.300	100.1	.004	.020
				MOTOR	BODY HARDNESS - 388 BHN.				
2	G-30	500	.011	-	5.994	5.400	101.7 202 T.	.004	.024
				MOTOR	BODY HARDNESS - 363 BHN.				
3	G-30	500	.011	-	6.015	5.600	105.8 308 T.	.005	.024

**NOTES:**

**TABLE 151: DATA FOR LIFE LINES**

<b>Date:</b> 2/9/82	<b>Material:</b> 4340
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-442-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 363/388 BHN.				
4	G-30	500	.011	-	6.112	5.500	105.6 414 T.	.006	.026
				MOTOR	BODY HARDNESS - 388 BHN.				
5	G-30	500	.011	-	6.020	6.000	113.4 527 T.	.0065	.0026
				MOTOR	BODY HARDNESS - 388 BHN.				
6	G-30	500	.011	-	5.991	6.000	112.9 640 T.	.007	.0028
				MOTOR	BODY HARDNESS - 363/388 BHN.				
7	G-30	500	.011	-	-	-	-	-	NOTE 1
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	G-30	550	.011	-	5.949	5.100	95.3	.002	.000
				MOTOR	BODY HARDNESS - 388/415 BHN.				
2	G-30	550	.011	-	6.021	5.700	107.8 203 T.	.003	.003

**NOTES:**

1 - nose broke out when finding size at start of cut.

2 - SFM increased 100/0 to see if wear rate on end cutting edge angle could be reduced.

**TABLE 152: DATA FOR LIFE LINES**

<b>Date:</b>	2/10/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-442-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
3	G-30	550	.011	-	6.040	5.300	100.6 304 T.	.006	.016 (1)
				MOTOR	BODY HARDNESS - 363/388 BHN.				
4	G-30	550	.011	-	6.041	5.700	108 412 T.	.009	.026
				MOTOR	BODY HARDNESS - 363 BHN.				
5	G-30	550	.011	-	6.047	5.800	110.2 522.2	.0115	.030
				MOTOR	BODY HARDNESS - 363/388 BHN.				
6	G-30	550	.011	-	-	-	-		NOTE 2

**NOTES:**

- 1 - small "nick" in flank - did not affect wear land.
- 2 - insert broke at start of cut.

**TABLE 153: DATA FOR LIFE LINES**

<b>Date:</b> 2/10/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CSDNN-165	
		<b>Insert:</b> SNG-554-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	G-30	600	.015	-	5.993	6.100	114.8	.003	
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	G-30	600	.015	-	5.994	5.800	109.2 224	.010N	.020 (1)
				MOTOR BODY HARDNESS - 363/388 BHN.					
3	G-30	600	.015	-	5.995	5.800	109. 333 T.	.016N	.028 (1)
	SPEED CHANGE			MOTOR BODY HARDNESS - 363 BHN.					
1	G-30	500	.015	-	6.017	5.100	-	.012N	NOTE 2 .016 (1)
				MOTOR BODY HARDNESS - 388 BHN.					
1	G-30	600	.011	-	6.072	5.800	110.6	.002	
				MOTOR BODY HARDNESS - 388 BHN.					
2	G-30	600	.011	-	6.027	5.800		.026N	NOTE 3 .030 (1)

**NOTES:** (1) Wear-land at junction of nose radius and end cutting edge angle.  
(2) Excessive wear on nose and in edge of work area. Test stopped.  
(3) Nose broke out at start of cut - loads increased immediately.

**TABLE 154: DATA FOR LIFE LINES**

<b>Date:</b> 2/10/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CSDNN - 164	
		<b>Insert:</b> SNG-453-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 388 BHN.					
1	NTK	600	.011	-	6.033	6.000	113.7	.012N .008F	
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	NTK	600	.011	-	6.066	5.500	104.8 219 T.	.024 .020	NOTE 1
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	NTK	450	.011	-	6.033	5.500	104.2	.0055F	
				MOTOR BODY HARDNESS - 388 BHN.					
2	NTK	450	.011	-	6.085	5.800	110.8 215 T.	.007	
				MOTOR BODY HARDNESS - 363 BHN.					
3	NTK	450	.011	-	5.982	5.600	105.2 320 T.	.012	
				MOTOR BODY HARDNESS - 363/388 BHN.					
4	NTK	450	.011	-	6.032	5.700	108. 428 T.	.0155	

**NOTES:**

1 - No nicks or chips-even wear on flank with increased amount of nose radius - speed too fast.

TABLE 155: DATA FOR LIFE LINES

<b>Date:</b> 2/10/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CSDNN - 164					
				<b>Insert:</b> SNG-453-820					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363 BHN.					
1	NTK	350	.011	-	5.991	5.800	109.2	.0045	
				MOTOR BODY HARDNESS - 363/388 BHN.					
2	NTK	350	.011	-	5.943	5.500	102.7 212 T.	.007	
				MOTOR BODY HARDNESS - 363/388 BHN.					
3	NTK	350	.011	-	5.969	5.900	110.6 323 T.	.008	
				MOTOR BODY HARDNESS - 363 BHN.					
4	NTK	350	.011	-	5.990	5.500	103.5 426 T.	.0095	
				MOTOR BODY HARDNESS - 363 BHN.					
5	NTK	350	.011	-	6.044	5.200	98.7 525 T.	.011	
				MOTOR BODY HARDNESS - 388 BHN.					
6	NTK	350	.011	-	5.995	5.300	99.8 625 T.	.012	NOTE 1

**NOTES:**  
1 - Tool hit shoulder of "rough turned" portion and flank chipped out near "edge of work" area and test had to be stopped.

TABLE 156: DATA FOR LIFE LINES



<b>Date:</b>	2/11/82	<b>Material:</b>	4340
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CSDNN-164
		<b>Insert:</b>	SNG-453-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN/REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR BODY HARDNESS - 363/388 BHN.					
1	NTK	400	.011	-	6.007	5.500	103.8	.005	
				MOTOR BODY HARDNESS - 388 BHN.					
2	NTK	400	.011	-	6.025	5.100	96.5 200 T.	.007	
				MOTOR BODY HARDNESS - 363/388 BHN.					
3	NTK	400	.011	-	6.023	5.900	111.6 312 T.	.0095	
				MOTOR BODY HARDNESS - 363/388 BHN.					
4	NTK	400	.011	-	6.040	5.800	110 422 T.	.0115	
				MOTOR BODY HARDNESS - 388 BHN.					
5	NTK	400	.011	-	5.995	5.500	103.6 526 T.	.014	

NOTES:

TABLE 157: DATA FOR LIFE LINES

<b>Date:</b> 2/11/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CSDNN-164	
		<b>Insert:</b> SNG-453-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
1	NTK	300	.011	-	5.935	5.800	108.1	.003	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
2	NTK	300	.011	-	6.006	5.500	103.7 212 T.	.0055	
				MOTOR	BODY HARDNESS - 363 BHN.				
3	NTK	300	.011	-	5.958	5.500	102.9 315 T.	.006	NOTE 1
				MOTOR	BODY HARDNESS - 388 BHN.				
4	NTK	300	.011	-	6.062	5.600	106.6 422	.0065	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
5	NTK	300	.011	-	5.983	5.900	110.9 533 T.	.0075	
				MOTOR	BODY HARDNESS - 388/415 BHN.				
6	NTK	300	.011	-	6.054	5.200	98.9 632 T.	.009	

**NOTES:**  
1 - Chip on flank 1/4" from nose radius - outside of "edge of work" area - probably due to "stringy" chips.

**TABLE 158: DATA FOR LIFE LINES**

<b>Date:</b> 2/11/82				<b>Material:</b> 4340					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CSDNN-164					
				SNG-453-820					
				<b>Insert:</b>					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
7	NTK	300	.011	-	6.054	5.200	98.9 731 T.	.0095	
				MOTOR	BODY HARDNESS - 388/415 BHN.				
8	NTK	300	.011	-	5.959	5.400	101 832 T.	.010	
				MOTOR	BODY HARDNESS - 363/388 BHN.				
9	NTK	300	.011	-	6.017	5.700	107.7 940 T.	.011	
				MOTOR	BODY HARDNESS - 388 BHN.				
10	NTK	300	.011	-	5.995	6.100	114.9 1055 T.	.012	NOTE (1)
				MOTOR	BODY HARDNESS - 388 BHN.				
1	NTK	500	.011	-	6.050	5.400	102.6	.002	
				MOTOR	BODY HARDNESS - 388 BHN.				
2	NTK	500	.011	-	5.957	5.500	102.9 205 T.	.007	
<b>NOTES:</b>  (1) Front flank broke at end of cut, near "edge of work" area - nose intact.									

TABLE 159: DATA FOR LIFE LINES

<b>Date:</b> 2/11/82		<b>Material:</b> 4340	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CSDNN-164	
		<b>Insert:</b> SNG-453-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				MOTOR	BODY HARDNESS - 388 BHN.				
3	NTK	500	.011	-	5.992	5.600	105.4 310 T.	.015	250   .012
				MOTOR	BODY HARDNESS - 363/388 BHN.				
1	NTK	550	.011	-	6.011	5.500	103.9	.008	
				MOTOR	BODY HARDNESS - 363 BHN.				
2	NTK	550	.011	-	5.960	6.100	114.2 218 T.	.011	
				MOTOR	BODY HARDNESS - 388/415 BHN.				
3	NTK	550	.011	-	6.035	5.400	102.4 320 T.	.0185	207   .012

NOTES:

TABLE 160: DATA FOR LIFE LINES

**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF  
CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS  
OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** 4340

**HARDNESS:** 388 BHN.

**INSERT:** TNMG-433

**SURFACE FEED:** 300  
FT./MIN.

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** 570

**FEEDRATE:** .015 IN/REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	150	80	180
.050	300	200	250
.100	580	420	300
.150	860	620	350

**INSERT:** SNG-453  
820

**SURFACE FEED:** 350  
FT./MIN.

**COOLANT:** TRIM-SOL  
20:1 TOP APPLICATION

**GRADE:** NTK

**FEEDRATE:** .011 IN./REV. HOLDER-45° L.A.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	120	60	110
.050	220	120	200
.100	440	250	360
.150	660	380	540

**INSERT:**

**SURFACE FEED:**

**COOLANT:**

**GRADE:**

**FEEDRATE:**

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD

**TABLE 161: DATA FOR TOOL LOAD CHARTS**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 4340

**HOLDER:** CTANR - 164

**HARDNESS:** 388 BHN.

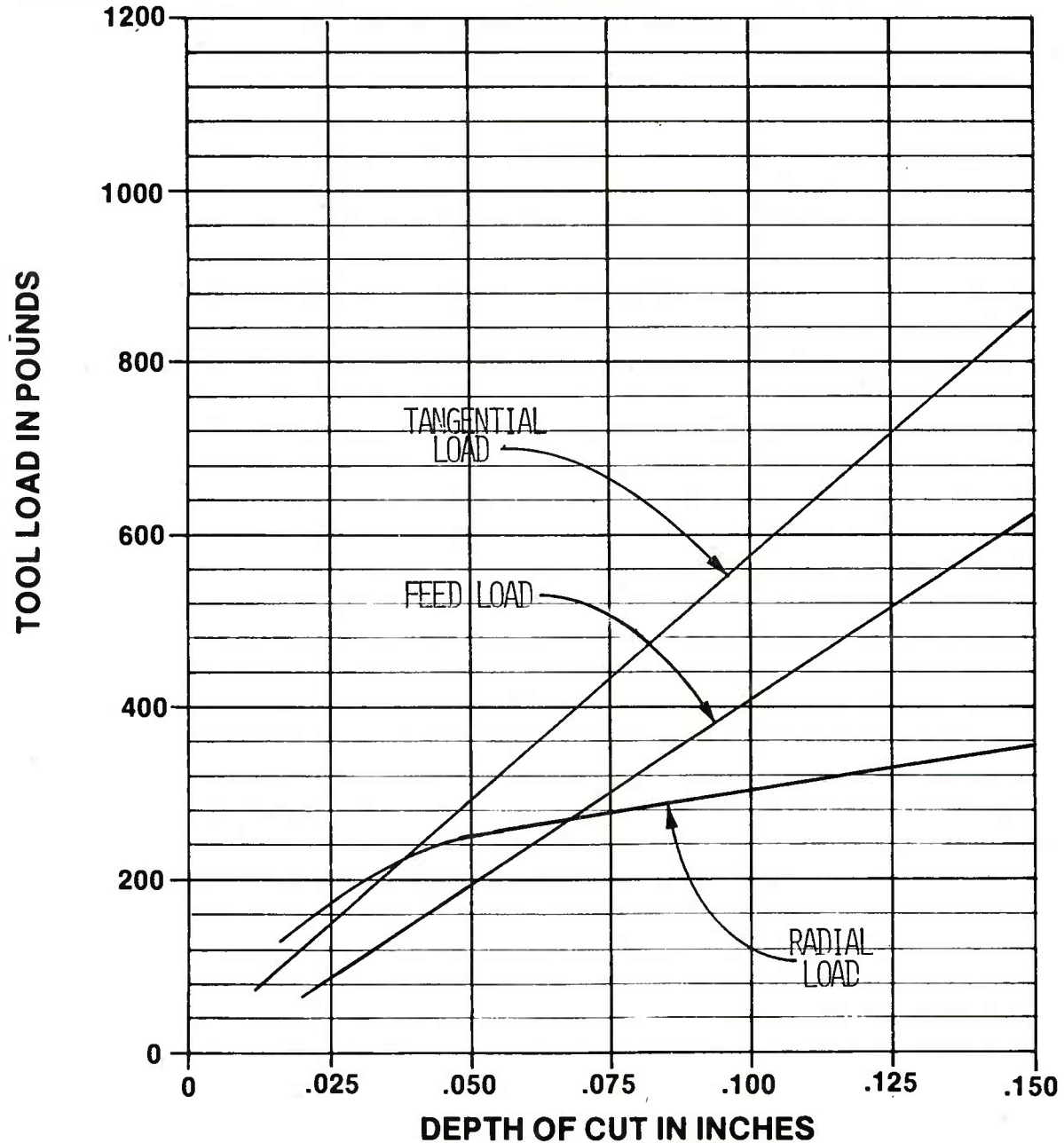
**INSERT:** TNMG-433-E48

**SURFACE SPEED:** 300 FT./MIN.

**GRADE:** 570

**FEED RATE:** .015 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 51: TOOL LOAD CHART**



### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** 4340

**HOLDER:** CSDNN - 164

**HARDNESS:** 388 BHN.

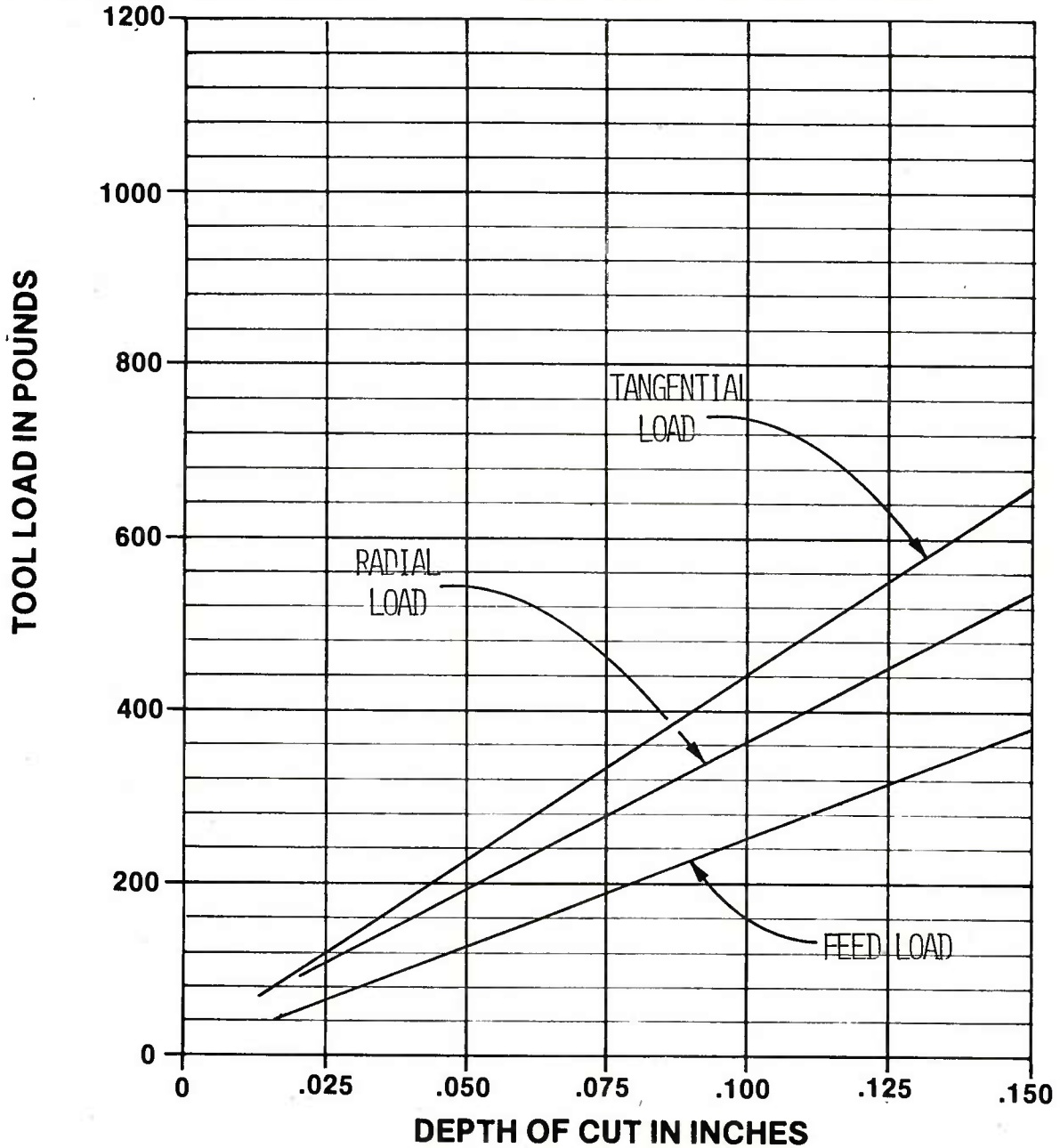
**INSERT:** SNG-453-820

**SURFACE SPEED:** 350 FT./MIN.

**GRADE:** NTK

**FEED RATE:** .011 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 52: TOOL LOAD CHART**

<b>Date:</b> 8/25/81				<b>Material:</b> HF-1						
<b>Depth of Cut:</b> .100" - APPROX.				<b>Coolant:</b> TRIM-SOL 20:1						
<b>Hardness:</b> 255/302 BHN.				<b>Tool Description:</b>						
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164						
				<b>Insert:</b> TNMG-433E48						

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				- FROM CONFIRMATION TESTS -					
1	570	400	.022	-	-	-	3000	.018	3000   .018
				- FROM PREVIOUS TESTS -					
2	570	700	.022	-	-	-	76	.028	49   .018
3	570	550	.022	-	-	-	248	.0105	425   .018
4	570	500	.022	-	-	-	211	.009	422   .018
5	570	450	.022	-	-	-	505	.0085	1070   .018
				- FROM CONFIRMATION TESTS -					
1	G-10	600	.015	-	-	-	2500	.015	2500   .015
				- FROM PREVIOUS TESTS -					
2	G-10	1000	.015	-	-	-	297	.005	635   .015
3	G-10	1200	.015	-	-	-	155	.0045	516   .015
4	G-10	800	.015	-	-	-	204.5	.0025	1227   .015

NOTES:

TABLE 162: DATA FOR LIFE LINES

<b>Date:</b>	8/26/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. .100 INCHES	<b>Coolant:</b>	NONE
<b>Hardness:</b>	286/269 BHN.	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
1	G-30	630	.015	-	-	-	2500	.015	2500 .015
				- FROM PREVIOUS TESTS -					
2	G-30	1000	.015	-	-	-	367	.008	688 .015
3	G-30	1400	.015	-	-	-	177	.0085	312 .015
4	G-30	800	.015	-	-	-	304	.004	1139 .015
5	G-30	1200	.015	-	-	-	190	.0055	517 .015

NOTES:

TABLE 163: DATA FOR LIFE LINES

<b>Date:</b>	7/28/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAP	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS - 269/255 BHN.					
1	570	420	.022	-	6.195	6	117	.0075	
2	570	420	.022	-	6.195	6	117 234 T.	.0085	
3	570	420	.022	-	6.195	6	117 351 T.	.0095	
4	570	420	.022	-	6.195	6	117 468 T.	.010	
			NEW	SHELL HARDNESS - 286/277 BHN.					
5	570	420	.022	-	6.215	6	117 585 T.	.011	
6	570	420	.022	-	6.215	6	117 702 T.	.012	
7	570	420	.022	-	6.215	6	117 819 T.	.012	
8	570	420	.022	-	6.215	6	117 936 T.	.0125	
			NEW	SHELL HARDNESS - 286/269 BHN.					
9	570	420	.022	-	6.195	6	116.7 1053 T.	.013	
10	570	420	.022	-	6.195	6	116.7 1170 T.	.0135	

**NOTES:**

**TABLE 164: DATA FOR LIFE LINES**

<b>Date:</b> 7/28/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. - .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433E48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
11	570	420	.022	-	6.195	12	233.5 1404 T.	.015	
				NEW SHELL HARDNESS - 286/269 BHN.					
12	570	420	.022	-	6.195	6	116.7 1521	.0155	
13	570	420	.022	-	6.195	6	116.7 1637 T.	.016	
14	570	420	.022	-	6.195	12	233.5 1871 T.	.0165	
				NEW SHELL HARDNESS - 286/269 BHN.					
15	570	420	.022	-	6.195	12	233.5 2105 T.		NOTE 1

**NOTES:**  
NOTE 1: Tool Broke when retracted from work.

TABLE 165: DATA FOR LIFE LINES

<b>Date:</b> 8/5/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433E48			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS - 286 BHN.					
1	570	420	.022	-	6.209	6	117	.0105	
2	570	420	.022	-	6.209	6	117 234 T.	.011	
				NEW SHELL HARDNESS - 286 BHN.					
3	570	420	.022	-	6.170	6	116 350 T.		NOTE 1
				NEW INSERT					
1	570	420	.022	-	6.200	6	117	.009	
2	570	420	.022	-	6.200	6	117 233 T.	.0095	
				NEW SHELL HARDNESS - 286 BHN.					
3	570	420	.022	-	6.285	6	118 352 T.	.0105	
4	570	420	.022	-	6.285	6	118 470 T.	.011	NOTE 2
5	570	420	.022	-	6.285	6	118 588 T.	.0115	
6	570	420	.022	-	6.285	6	118 706 T.	.0115	

**NOTES:**

NOTE 1: Flank chipped out.

NOTE 2: Coolant flow stopped approximately 1" from end of cut.

**TABLE 166: DATA FOR LIFE LINES**



<b>Date:</b>	8/5/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				NEW SHELL HARDNESS - 286			BHN.		
7	570	420	.022	-	6.280	6	118 824 T.	.012	
8	570	420	.022	-	6.280	6	118 942 T.	.012	
9	570	420	.022	-	6.280	6	118 1060 T.	.013	
10	570	420	.022	-	6.280	6	118 1178 T.	.013	
				NEW SHELL HARDNESS - 286			BHN.		
11	570	420	.022	-	6.283	6	118 1296 T.	.0135	
12	570	420	.022	-	6.283	6	118 1414 T.	.0135	
13	570	420	.022	-	6.283	6	118 1532 T.	.014	
14	570	420	.022	-	6.283	6	118 1650 T.	.014	
				NEW SHELL HARDNESS - 286			BHN.		
15	570	420	.022	-	6.284	6	118 1768 T.	.014	
16	570	420	.022	-	6.284	6	118 1886 T.	.0145	

**NOTES:**

**TABLE 167: DATA FOR LIFE LINES**

<b>Date:</b> 8/5/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
17	570	420	.022	-	6.284	6	118 2004 T.	.0145	—
18	570	420	.022	-	6.284	6	118 2122 T.	.015	—
				NEW SHELL HARDNESS - 269 BHN.					—
19	570	420	.022	-	6.165	6	116 2238 T.	.016	—
20	570	420	.022	-	6.165	6	116 2354 T.	.016+	—
21	570	420	.022	-	6.165	6	116 2470 T.	.0165	—
22	570	420	.022	-	6.165	6	116 2586 T.	.017	NOTE 1
									—
									—
									—
									—
									—
									—
									—

**NOTES:**  
 NOTE 1: Chipping started on nose and flank.

**TABLE 168: DATA FOR LIFE LINES**

<b>Date:</b> 8/5/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433 E48			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS	- 286 BHN.			
1	570	420	.022	-	6.185	6/6	116.5	.0095	
2	570	420	.022	-	6.185	6/12	116.5 233 T.	.010	
3	570	420	.022	-	6.185	6/18	116.5 349.5 T.	.0105	
4	570	420	.022	-	6.185	6/24	116.5 446 T.	.0115	
	DATE - 8/6/81		NEW	SHELL	HARDNESS	- 286 BHN.			
5	570	420	.022	-	6.165	6/6	116.2 582 T.	.0115	
6	570	420	.022	-	6.165	6/12	116.2 698.4 T.	.012	NOTE 1
7	570	420	.022	-	6.165	6/18	116.2 814.6 T.	.013	
8	570	420	.022	-	6.165	6/24	116.2 930.8 T.	.013+	

**NOTES:**  
 NOTE 1: Coating is starting to flake.

**TABLE 169: DATA FOR LIFE LINES**

<b>Date:</b> 8/6/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				NEW SHELL HARDNESS - 286			BHN.		
9	570	420	.022	-	6.200	6/6	115.4 1046 T.	.013	
10	570	420	.022	-	6.200	6/12	115.4 1161 T.	.014	
11	570	420	.022	-	6.200	6/18	115.4 1276.8 T.	.014	
12	570	420	.022	-	6.200	6/24	115.4 1392 T.	.015	
				NEW SHELL HARDNESS - 286			BHN.		
13	570	420	.022	-	6.180	6/6	116.5 1508 T.	.015	
14	570	420	.022	-	6.180	6/12	116.5 1624.9 T.	.017	
15	570	420	.022	-	6.180	6/18	116.5 1741 T.	.017	
16	570	420	.022	-	6.180	6/24	116.5 1974 T.	.0175	
17	570	420	.022	-	6.195	4/-	78 2051 T.		NOTE 2

**NOTES:**

NOTE 2: Nose broke out.

**TABLE 170: DATA FOR LIFE LINES**

<b>Date:</b>	8/13/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS	293/286 BHN.			
1	570	400	.022	-	6.125	6	117	.-	NOTE 1
2	570	400	.022	-	6.125	6	117 234.3 T.	.006	
3	570	400	.022	-	6.125	12	2343 469 T.	.0075	
				NEW SHELL	HARDNESS	302/286 BHN.			
4	570	400	.022	-	6.185	12	233.2 702 T.	.008	
5	570	400	.022	-	6.185	12	233.2 935 T.	.0095	SHE NOTE 1
				NEW SHELL	HARDNESS	302/286 BHN.			
6	570	400	.022	-	6.205	12	233.9 1169 T.	.0105	
7	570	400	.022	-	6.205	12	233.9 1403 T.	.011	NOTE 2

**NOTES:**

NOTE 1: Slight build-up near chip groove.

NOTE 2: Slight chip on nose radius - test stopped.

**TABLE 171: DATA FOR LIFE LINES**

<b>Date:</b> 8/13/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433E48			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS	293/286 BHN.				
1	570	400	.022	-	6.220	6	117.2	.004	
2	570	400	.022	-	6.220	6	117.2 235 T.	.0065	
3	570	400	.022	-	6.220	12	234.5 469 T.	.008	
				NEW SHELL HARDNESS	286/269 BHN.				
4	570	400	.022	-	6.190	12	233.4 702 T.	.009	
5	570	400	.022	-	6.190	12	233.4 935 T.	.010	NOTE 1
				NEW SHELL HARDNESS	302/293 BHN.				
6	570	400	.022	-	6.205	12	234 1169 T.	.0125	
7	570	400	.022	-	6.205	10	195 1403 T.	-	NOTE 2

**NOTES:**  
NOTE 1: Slight build-up in chip groove.  
  
NOTE 2: Nose of tool broke out - test stopped excessive runout and tool "Sing".

**TABLE 172: DATA FOR LIFE LINES**



<b>Date:</b> 8/13/81				<b>Material:</b> HF-1					
<b>Depth of Cut:</b> APPROX. .100				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS 293/286			BHN.		
1	570	400	.022	-	6.175	6	116.4	.005	
2	570	400	.022	-	6.175	6	116.4 233 T.	.008	
3	570	400	.022	-	6.175	12	233.8 466 T.	.0085	NOTE 1
				NEW SHELL HARDNESS 293/286			BHN.		
4	570	400	.022	-	6.205	12	234 700 T.	.009	NOTE 2
				NEW INSERT					
1	570	400	.022	-	.195	9	175.2	.006	
				NEW SHELL HARDNESS 302/286			BHN.		
2	570	400	.022	-	6.195	12	233.5 409 T.	.0075	
3	570	400	.022	-	6.195	12	233.5 642.5 T.	.009	
				NEW SHELL HARDNESS 293/269			BHN.		
4	570	400	.022	-	6.220	12	234.5 877 T.	.0095	

**NOTES:**  
  
NOTE 1: Some build-up in chip breaker groove.  
  
NOTE 2: Part slipped in chuck - part loosened up. Tool broke.

**TABLE 173: DATA FOR LIFE LINES**

<b>Date:</b> 8/13/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
5	570	400	.022	-	6.220	12	234.5 1112 T.	.010	
				NEW SHELL HARDNESS 286/269 BHN.					
6	570	400	.022	-	6.205	12	233.9 1346 T.	.0105	
7	570	400	.022	-	6.205	12	233.9 1580 T.	.011	
				NEW SHELL HARDNESS 286/269 BHN.					
8	570	400	.022	-	6.210	12	234.1 1814 T.	.013	
9	570	400	.022	-	6.210	12	234.1 2048 T.	.0135	
				NEW SHELL HARDNESS 286/269 BHN.					
10	570	400	.072	-	6.210	12	234.1 2282 T.	.0145	
11	570	400	.022	-	6.210	12	234.1 2516 T.	.0150	
				DATE 8/14/81 NEW SHELL HARDNESS 302 BHN.					
12	570	400	.022	-	6.207	12	234.1 2750 T.	.0155	
13	570	400	.022	-	6.207	12	234 2984 T.	.016	
<b>NOTES:</b>									

**TABLE 174: DATA FOR LIFE LINES**

<b>Date:</b> 8/14/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433E48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				NEW SHELL HARDNESS 277 BHN.					
14	570	400	.022	-	6.226	12	234.1 3219 T.	.017	
15	570	400	.022	-	6.226	12	234.7 3452 T.	.018	
				NEW SHELL HARDNESS 269 BHN.					
16	570	400	.022	-	6.192	12	233.4 3686 T.	.0185	
17	570	400	.022	-	6.192	12	233.4 3918 T.	.020	
				NEW SHELL HARDNESS 277 BHN.					
18	570	400	.022	-	6.225	12	234.7 4154 T.	.024	NOTE 1

**NOTES:**  
 NOTE 1: Insert badly worn - edge chipping - nose radius breaking down.

**TABLE 175: DATA FOR LIFE LINES**

<b>Date:</b> 8/14/81				<b>Material:</b> HF-1					
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433E48					
RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS	302/286 BHN.			
1	570	400	.022	-	6.195	12	233.5	.0065	
2	570	400	.022	-	6.195	12	233.5 467 T.	.010	
				NEW SHELL	HARDNESS	302/293 BHN.			
3	570	400	.022	-	6.200	12	233.7 700 T.	.0105	
4	570	400	.022	-	6.200	12	233.7 934 T.	.011	
				NEW SHELL	HARDNESS	293 BHN.			
5	570	400	.022	-	6.205	12	234 1168 T.	.012	
6	570	400	.022	-	6.205	12	234 1402 T.	.0125	
DATE 8/17/81				NEW SHELL	HARDNESS	293/286 BHN.			
7	570	400	.022	-	6.207	12	234 1636 T.	.0135	NOTE 1
8	570	400	.022	-	6.207	12	234 1870 T.	.0145	
<b>NOTES:</b> NOTE 1: Small "nick" at nose radius.									

TABLE 176: DATA FOR LIFE LINES

<b>Date:</b> 8/17/81				<b>Material:</b> HF-1					
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433 E48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				NEW SHELL HARDNESS 293 BHN.					
9	570	400	.022	-	6.230	12	234.8 2105 T.	.015	
10	570	400	.022	-	6.230	12	234.8 2340 T.	.0155	
				NEW SHELL HARDNESS - 293/277 BHN.					
11	570	400	.022	-	6.185	12	233.2 2573 T.	.016	
12	570	400	.022	-	6.185	12	233.2 2806 T.	.016+	
				NEW SHELL HARDNESS 286/277 BHN.					
13	570	400	.022	-	6.210	12	234.1 3040 T.	.017	
14	570	400	.022	-	6.210	12	234.1 3274 T.	.019	
				NEW SHELL HARDNESS 302/286 BHN.					
15	570	400	.022	-	6.205	12	234 3508 T.	.0195	
16	570	400	.022	-	6.205	12	234 3742 T.	.021	

NOTES:

TABLE 177: DATA FOR LIFE LINES





<b>Date:</b> 8/6/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS 286 BHN.				
1	G-30	470	.022	-	6.210	2-1/2	48.7	.0015	NOTE 1
2	G-30	470	.022	-	6.210	6/12	117 165 T.	.002	
3	G-30	470	.022	-	6.210	6/18	117 282 T.	.003	
4	G-30	470	.022	-	6.210	6/24	117 399 T.	.0035	
				NEW SHELL	HARDNESS 277 BHN.				
5	G-30	470	.022	-	6.220	6/6	117.24 516 T.	.0045	
6	G-30	470	.022	-	6.220	6/12	117.24 633 T.	.0045	
7	G-30	470	.022	-	6.220	12/24	234.5 867.5 T.	.005	
				NEW SHELL	HARDNESS 269 BHN.				
8	G-30	470	.022	-	-	.500	-		NOTE 2

**NOTES:**

NOTE 1: - Bad finish - chatter.

NOTE 2: - Tool Broke

**TABLE 179: DATA FOR LIFE LINES**

<b>Date:</b> 8/6/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. - .100		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS - 269 BHN.					
1	G-30	630	.015	-	6.240	5	98	0	
2	G-30	630	.015	-	6.240	18	352.8 451 T.	.0025	
				NEW SHELL HARDNESS - 269 BHN.					
3	G-30	630	.015	-	6.185	12	233 683 T.	.0035	
4	G-30	630	.015	-	6.185	12	233 916 T.	.005	
			8/7/81	- NEW SHELL HARDNESS - 269 BHN.					
5	G-30	630	.015	-	6.210	12	234 1150 T.	.0055	
6	G-30	630	.015	-	6.210	12	234 1384 T.	.006 .008	NOTE 1
				NEW SHELL HARDNESS - 269 BHN.					
7	G-30	630	.015	-	6.195	12	233.5 1617 T.	.007 .009	
8	G-30	630	.015	-	6.195	12	233.5 1850 T.	.0075 .0095	

**NOTES:**

Top value in "wear land" is the wear land at the flank. The bottom value is the wear land at the "Edge of Work" area.

NOTE 1: - Shop power failure - almost to end of cut.  
Tool was retracted before spindle stopped.  
Continued with test.

**TABLE 180: DATA FOR LIFE LINES**

<b>Date:</b>	8/7/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
					NEW SHELL HARDNESS - 286 BHN.				
9	G-30	630	.015	-	6.195	12	233.5 2083 T.	.0075 .0105	
10	G-30	630	.015	-	6.195	12	233.5 2316 T.	.0085 .012	
					NEW SHELL HARDNESS - 286 BHN.				
11	G-30	630	.015	-	6.185	12	233 2549 T.	.010 .0135	
12	G-30	630	.015	-	6.185	12	233 2782 T.	.011 .015	

**NOTES:**

Top value in "wear land" is the wear land at the flank.  
The bottom value is the wear land at the "Edge of Work" area.

**TABLE 181: DATA FOR LIFE LINES**

<b>Date:</b> 8/7/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. - .100		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS - 269 BHN.					
1	G-30	630	.015	-	6.225	12	234.6	.003 .004	
2	G-30	630	.015	-	6.225	12	234.6 469.2 T.	.004 .0065	
				NEW SHELL HARDNESS - 269 BHN					
3	G-30	630	.015	-	6.210	12	234.1 703.3 T.	.005 .0075	
4	G-30	630	.015	-	6.210	12	234.1 937.4 T.	.006 .0085	
				NEW SHELL HARDNESS - 286 BHN					
5	G-30	630	.015	-	6.200	12	233.7 1171.1 T.	.007 .011	
6	G-30	630	.015	-	6.200	12	233.7 1404.8 T.	.008 .0125	
				NEW SHELL HARDNESS - 277 BHN					
7	G-30	630	.015	-	6.250	12	235.6 1640.4 T.	.0085 .0135	
8	G-30	630	.015	-	6.250	12	235.6 1876 T.	.0095 .014	

**NOTES:**  
 Top value in "wear land" is the wear land at the blank.  
 The bottom value is the wear land at the "Edge of Work" area.

**TABLE 182: DATA FOR LIFE LINES**



<b>Date:</b> 8/10/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. - .100		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS 277/269 BHN.					
1	G-10	640	.015	-	6.195	6/24	116.7 .000 .001		
2	G-10	640	.015	-	6.195	16/18	116.7 234 T. .0025 .003		
3	G-10	640	.015	-	6.195	12/12	233.5 467 T. .004 .006		
				NEW SHELL HARDNESS 293/286 BHN.					
4	G-10	640	.015	-	6.190	12/24	233.4 700 T. .006 .008		
5	G-10	640	.015	-	6.190	12/12	233.4 934 T. .0075 .010		
				NEW SHELL HARDNESS 286/277 BHN.					
6	G-10	640	.015	-	6.200	7.5/-	146 1080 T.	-	NOTE 1

**NOTES:**

NOTE 1: - Tool broke - hole in shell.

Top value in "wear land" is the wear land at the flank.  
The lower value is the wear land at the "Edge of Work" area.

**TABLE 184: DATA FOR LIFE LINES**



<b>Date:</b>	8/10/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							SHELL HARDNESS 286/277 BHN.		
1	G-10	640	.015	-	6.195	12	235.5	.000 .002	
2	G-10	640	.015	-	6.195	12	233.5 467.0 T.	.001+ .0025	
							NEW SHELL HARDNESS 277/262 BHN.		
3	G-10	640	.015	-	6.185	12	233 700 T.	.004 .007	
4	G-10	640	.015	-	6.185	1	233 933 T.	.0065 .009	
							NEW SHELL HARDNESS 293/286 BHN.		
5	G-10	640	.015	-	6.230	12	234.9 1168 T.	.008 .0115	NOTE 1
6	G-10	640	.015	-	6.230	12	234.9 1403 T.	.0085 .012	

**NOTES:**

NOTE 1: - Nick in flank outside cutting area.

**TABLE 185: DATA FOR LIFE LINES**

<b>Date:</b>	8/11/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. - .100	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS	293/286 BHN.			
1	G-10	600	.015	-	6.230	12	234.8	.002	
2	G-10	600	.015	-	6.230	12	234.8	.0025	
							469.7 T.	.0045	
				NEW SHELL	HARDNESS	293/277 BHN.			
3	G-10	600	.015	-	6.220	12	234.4	.0055	
4	G-10	600	.015	-	6.220	12	704.2 T.	.006	
							234.4	.0075	
							938.6 T.	.007	
				NEW SHELL	HARDNESS	293/286 BHN.			
5	G-10	600	.015	-	6.200	12	233.7	.008	NOTE 1
6	G-10	600	.015	-	6.200	12	1172.3 T.	.008	
							233.7	.009	
							1405 T.	-	
				NEW SHELL	HARDNESS	302 BHN.			
7	G-10	600	.015	-	6.195	12	233.5		
8	G-10	600	.015	-	6.195	12	1638.5 T.	.0095	
							233.5		
							1873 T.	.0105	

**NOTES:**

NOTE 1: - "Edge of Work" area wear has stopped and looks good - no excessive wear.

Top value in "wear land" is the wear land at the flank.  
The bottom value is the wear land at the "Edge of Work" area.

**TABLE 186: DATA FOR LIFE LINES**



<b>Date:</b> 8/12/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. - .100				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164			
				<b>Insert:</b> CNG-454-820			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL HARDNESS 293 BHN.					
1	G-10	600	.015	-	6.220	15	293	.0025	
				NEW SHELL HARDNESS 302/293 BHN.					
2	G-10	600	.015	-	6.190	12	233.3 526 T.	.0045 .0055	
3	G-10	600	.015	-	6.190	12	233.3 760 T.	.0055 .0065	
				NEW SHELL HARDNESS 286/269 BHN.					
4	G-10	600	.015	-	6.205	12	234 994 T.	.0075 .0085	
5	G-10	600	.015	-	6.205	12	234 1228 T.	.008 .009	
				NEW SHELL HARDNESS 286 BHN.					
6	G-10	600	.015	-	6.195	12	233.5 1462 T.	.009 .0105	
7	G-10	600	.015	-	6.195	12	233.5 1696 T.	.010 .011+	
				NEW SHELL HARDNESS 302/286 BHN.					
8	G-10	600	.015	-	6.185	12	233 1929 T.	.011 .0125	

**NOTES:**

**TABLE 188: DATA FOR LIFE LINES**

[illegible]**TABLE 189: DATA FOR LIFE LINES**

<b>Date:</b> 8/12/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. - .100	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				SHELL	HARDNESS	- 293/286	BHN.		
1	G-10	590	.022	-	6.200	4.8	-	-	NOTE 1
2	G-10	590	.022	-	6.200	4.2	-	-	TOOL BROKE
				NEW INSERT					
1	G-10	590	.022	-	6.200	9	-	-	NOTE 2
				NEW INSERT					
1	G-10	640	.022	-	6.200	.5	-	-	TOOL BROKE
				8/13/81	NEW INSERT				
1	G-10	640	.022	-	6.200	5.5	-	-	NOTE 3

**NOTES:**

NOTE 1: Tip "nicked" out slightly - slight decrease in vertical and feed loads.

NOTE 2: Excessive crater with cracks from crater to back edge of tool - See Photo 1

NOTE 3: Excessive crater with cracks from crater to back edge and leading edge of tool - See Photo 2.

**TABLE 190: DATA FOR LIFE LINES**



**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** HF-1

**HARDNESS:** 286 BHN

**INSERT:** TNMG-433

**SURFACE FEED:** 400  
FT./MIN.

**COOLANT:** NONE

**GRADE:** 570

**FEEDRATE:** .022 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	420	180	220
.100	740	360	300
.150	1000	560	360
.200	1320	760	440

**INSERT:** CNG-454  
.008 x 200

**SURFACE FEED:** 600  
FT./MIN.

**COOLANT:** NONE

**GRADE:** G-10

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	260	110	160
.100	500	260	200
.150	720	400	230
.200	920	510	260

**INSERT:** CNG-454  
.008 x 20

**SURFACE FEED:** 630  
FT./MIN.

**COOLANT:** NONE

**GRADE:** G-30

**FEEDRATE:** .015 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.050	280	120	160
.100	500	260	200
.150	720	400	230
.200	920	530	280

**TABLE 191: DATA FOR TOOL LOAD CHARTS**

## TOOL LOAD VERSUS DEPTH OF CUT

Material:	HF-1	Holder:	0° LEAD ANGLE
Hardness:	286 BHN	Insert:	TNMG-433
Feed Rate:	.022 IN./REV.	Grade:	570
Surface Speed:	400 FT./MIN.	Coolant:	NONE

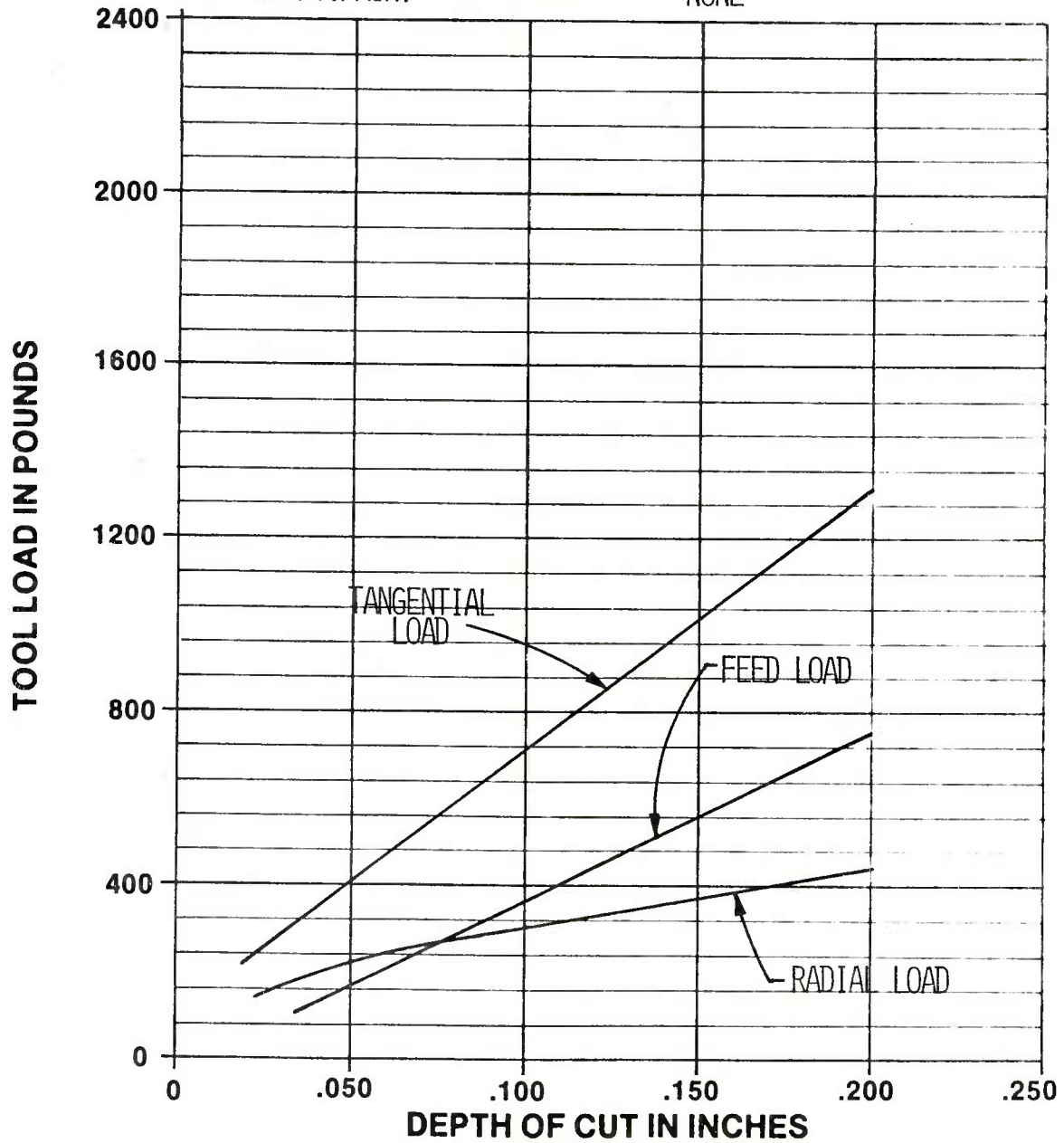


FIGURE 53: TOOL LOAD CHART

## TOOL LOAD VERSUS DEPTH OF CUT

Material:	HF-1	Holder:	0° LEAD ANGLE
Hardness:	286 BHN	Insert:	CNG-454 - 820
Feed Rate:	.015 IN./REV.	Grade:	G-10
Surface Speed:	600 FT./MIN.	Coolant:	NONE

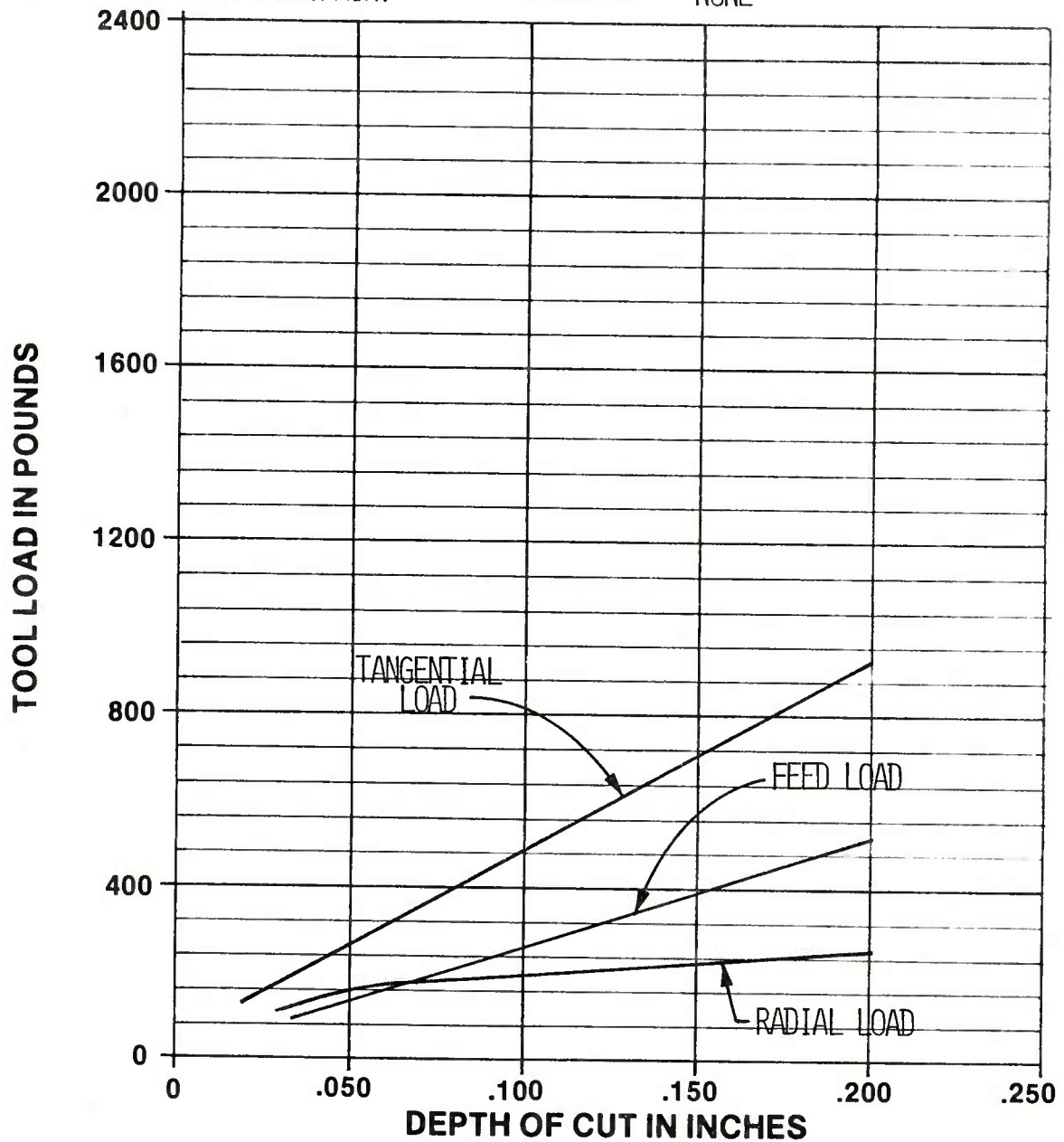


FIGURE 54: TOOL LOAD CHART

## TOOL LOAD VERSUS DEPTH OF CUT

<b>Material:</b>	HF-1	<b>Holder:</b>	0° LEAD ANGLE
<b>Hardness:</b>	286 BHN	<b>Insert:</b>	CNG-454 - 820
<b>Feed Rate:</b>	.015 IN./REV.	<b>Grade:</b>	G-30
<b>Surface Speed:</b>	630 FT./MIN.	<b>Coolant:</b>	NONE

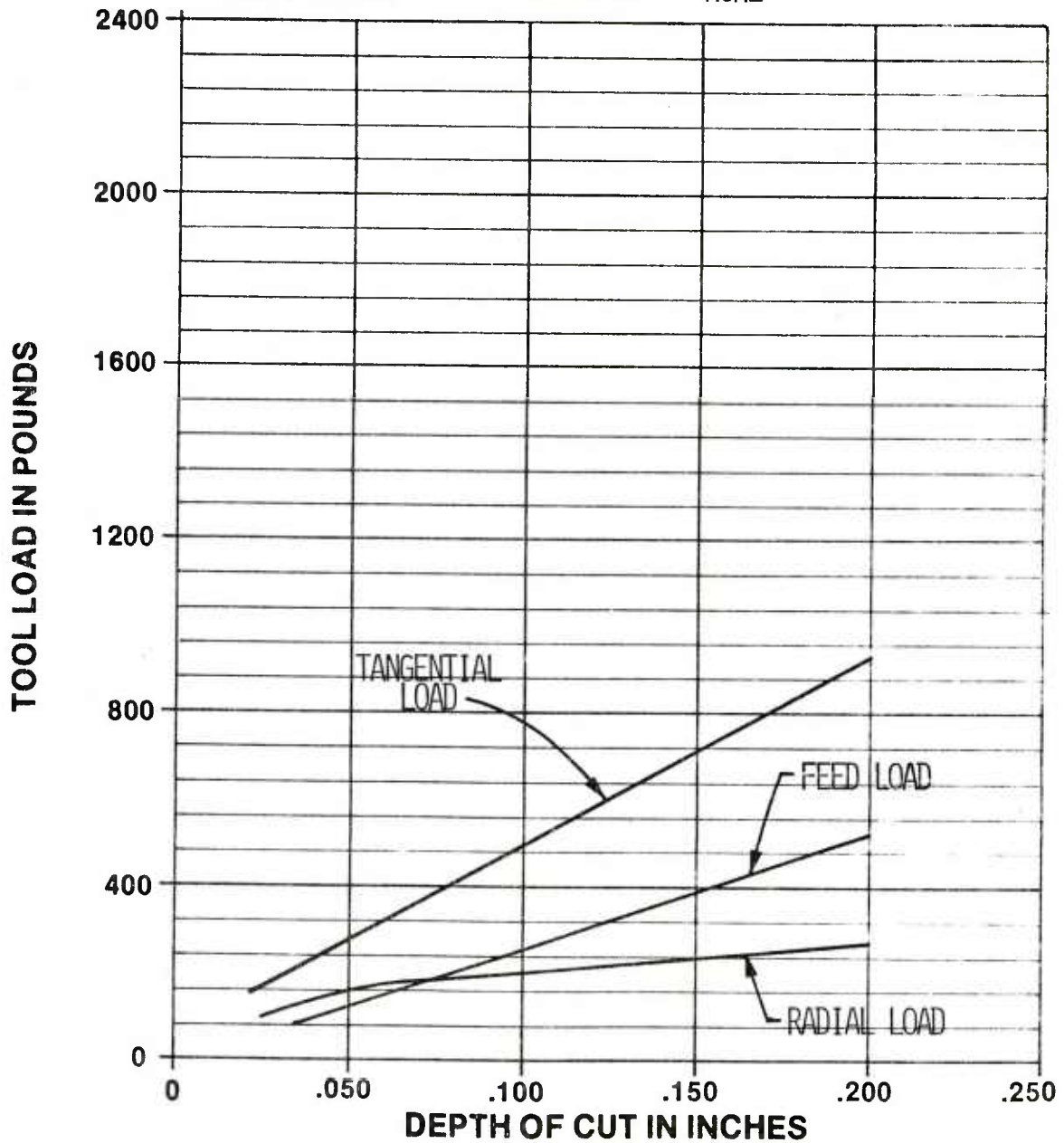


FIGURE 55: TOOL LOAD CHART

<b>Date:</b> 12/4/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> .050 INCHES	<b>Coolant:</b> -
<b>Hardness:</b> SEE FIGURE	<b>Tool Description:</b>
<b>Coolant Application:</b>	<b>Holder:</b> SEE FIGURE
	<b>Insert:</b> SEE FIGURE

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
			LIFE-LINE DATA FROM TEST						
1	KC-910	340	.011	-	-	-	-	-	3500   .009
2	KC-910	500	.011	-	-	-	-	-	380   .009
3	KC-910	650	.011	-	-	-	-	-	146   .009
			LIFE-LINE DATA FROM TEST						
1	G-30	590	.011	-	-	-	-	-	2500   .017
			LIFE-LINE DATA FROM PREVIOUS TEST						
2	G-30	1000	.011	-	-	-	-	-	107   .017
3	G-30	900	.011	-	-	-	-	-	284   .017
4	G-30	800	.011	-	-	-	-	-	403   .017

**NOTES:**

**TABLE 192: DATA FOR LIFE LINES**

<b>Date:</b> 12/4/81 <b>Depth of Cut:</b> .050 INCHES <b>Hardness:</b> SEE FIGURE <b>Coolant Application:</b>	<b>Material:</b> HF-1 <b>Coolant:</b> - <b>Tool Description:</b> <b>Holder:</b> SEE FIGURE <b>Insert:</b> SEE FIGURE
--	--

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
			LIFE-LINE DATA FROM TEST						
1	G-10	610	.011	-	-	-	-	-	2600   .017
2	G-10	550	.011	-	-	-	-	-	3600   .017
			LIFE-LINE DATA FROM PREVIOUS TEST						
3	G-10	1000	.011	-	-	-	-	-	886   .017
4	G-10	1200	.011	-	-	-	-	-	646   .017
5	G-10	1400	.011	-	-	-	-	-	407   .017

**NOTES:**

**TABLE 193: DATA FOR LIFE LINES**



<b>Date:</b> 11/9/81				<b>Material:</b> HF-1					
<b>Depth of Cut:</b> .050				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164					
				<b>Insert:</b> TNMG-433-E-48					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340			BHN.		
1	570	340	.011	-	6.120	6.400	123	.0025	N. NOTE 1
2	570	340	.011	-	6.120	6.000	115.4 238 T	.004	N. NOTE 1
3	570	340	.011	-	6.120	6.000	115.4 354 T	.006	N. NOTE 2
4	570	340	.011	-	6.120	6.000	115.4 469 T	.0065	N.
				PROJECTILE HARDNESS - 340			BHN.		
5	570	340	.011	-	6.020	12.400	234.5 704 T	.0075	N.
6	570	340	.011	-	6.020	12.000	226.9 931 T	.009	N.
				PROJECTILE HARDNESS - 364			BHN.		
7	570	340	.011	-	6.104	13.000	249.3 1180 T	.010	N.
8	570	340	.011	-	6.104	12.000	230 1410 T	.012	N.
				PROJECTILE HARDNESS - 364			BHN.		
9	570	340	.011	-	6.004	13.000	245.2 1655 T	.030	

**NOTES:**  
"N" - wear-land reading on nose radius  
1. continuous chip  
2. 1/2" diam. curl - 2" to 3" long

TABLE 194: DATA FOR LIFE LINES

<b>Date:</b>	11/9/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	.050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
1	570	320	.011	-	6.004	12.000	226	.0065	N.
		DATE 11/10/81		PROJECTILE HARDNESS - 340			BHN.		
2	570	320	.011	-	6.073	12.000	228.9 455 T.	.007	N.
3	570	320	.011	-	6.073	12.000	228.9 684 T.	.0095	N.
				PROJECTILE HARDNESS - 340			BHN.		
4	570	320	.011	-	6.051	12.000	228 912 T.	.013	N.
5	570	320	.011	-	6.051	12.000	228 1140 T.	.018	N. NOTE 1

**NOTES:**  
 1. Test stopped - excessive increase in wear-land

**TABLE 195: DATA FOR LIFE LINES**

<b>Date:</b> 11/10/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> .050				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433-E-48			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340 BHN.					
1	570	360	.011	-	6.061	12.900	245.6	.005	N.
2	570	360	.011	-	6.061	12.000	228.4 474 T.	.0075	N.
				PROJECTILE HARDNESS - 340 BHN.					
3	570	360	.011	-	6.050	12.400	235.6 710 T.	.0085	N.
4	570	360	.011	-	6.050	12.000	228 938 T.	.0095	N.
				PROJECTILE HARDNESS - 364 BHN.					
5	570	360	.011	-	6.119	12.900	247.9 1186 T.	.0125	
6	570	360	.011	-	6.119	6.000	115.3 1304 T.	.0155	NOTE 1

**NOTES:**  
 1. Test stopped - too large increase in wear-land

**TABLE 196: DATA FOR LIFE LINES**

<b>Date:</b> 11/11/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> .050"				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433-E-68			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340 BHN.					
1	570	400	.011	-	6.019	12.900	244	.006	
2	570	400	.011	-	6.019	12.000	226.9 471 T.	.008	NOTE 1
				PROJECTILE HARDNESS - 340 BHN.					
1	570	400	.011	-	6.085	12.900	246.6	.005	
2	570	400	.011	-	6.085	12.000	229.3 476 T.	.0065	
				PROJECTILE HARDNESS - 340 BHN.					
3	570	400	.011	-	6.041	12.500	237.2 713 T.	.0095	
4	570	400	.011	-	6.041	12.000	227.7 941 T.	.012	NOTE 2

**NOTES:**  
 1. "Coating" chipped on nose radius and picked up burr  
 2. "Chip" in flank at "edge of work" area

**TABLE 197: DATA FOR LIFE LINES**

<b>Date:</b> 11/11/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> .050	<b>Coolant:</b> TRIM-SOL 20:1
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> TOP	<b>Holder:</b> CTANR-164
	<b>Insert:</b> TNMG-433-E-48

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
1	570	340	.011	-	6.030	12.000	227.3	.005	
2	570	340	.011	-	6.030	12.000	227.3 455 T.	.007	
				PROJECTILE HARDNESS - 340			BHN.		
3	570	340	.011	-	6.020	12.000	226.9 682 T.	.0075	
4	570	340	.011	-	6.020	12.000	226.9 909 T.	.0085	
DATE: 11/12/81				PROJECTILE HARDNESS - 364			BHN.		
5	570	340	.011	-	6.161	12.000	232.3 1141 T.	.014	
6	570	340	.011	-	6.161	6.000	116.1 1257 T.	.016	
7	570	340	.011	-	6.161	6.000	116.1 1373 T.	.020	

**NOTES:**

**TABLE 198: DATA FOR LIFE LINES**



<b>Date:</b> 11/12/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> .050		<b>Coolant:</b> TRIM-SOL 20:1	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> TOP		<b>Holder:</b> CTANR-164	
		<b>Insert:</b> TNMG-433-E-48	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387/364 BHN.					
1	570	340	.011	-	6.077	12.900	246.3	.0045	
2	570	340	.011	-	6.077	12.00	229 475 T.	.005	
				PROJECTILE HARDNESS - 340 BHN.					
3	570	340	.011	-	6.078	12.900	246.3 721 T.	.007	
4	570	340	.011	-	6.078	7.900	150.8 872 T.	.0085	
				PROJECTILE HARDNESS - 361 BHN.					
5	570	340	.011	-	6.062	12.500	238 1110 T.	.0095	
6	570	340	.011	-	6.062	12.00	228.5 1339 T.	.0105	
				PROJECTILE HARDNESS - 340 BHN.					
7	570	340	.011	-	6.107	6.500	124.7 1464 T.	.013	
8	570	340	.011	-	6.107	6.000	115 1579 T.	.020	NOTE 1

**NOTES:**

1. Test stopped - too large increase in wear-land

TABLE 199: DATA FOR LIFE LINES



<b>Date:</b>	11/12/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	.050	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340 BHN.					
1	KC-910	340	.011	-	6.107	12.000	230.2	.003	
				PROJECTILE HARDNESS - 364 BHN.					
2	KC-910	340	.011	-	6.095	12.900	247 477 T.	.004	
3	KC-910	340	.011	-	6.095	12.000	229.8 707 T.	.005	
	DATE	11/13/81		PROJECTILE HARDNESS - 340 BHN.					
4	KC-910	340	.011	-	6.070	12.000	228.8 936 T.	.0055	
5	KC-910	340	.011	-	6.070	9.500	181.1 1117 T.	.0055	
				PROJECTILE HARDNESS - 364 BHN.					
6	KC-910	340	.011	-	6.067	12.500	238.3 1355 T.	.0065	
7	KC-910	340	.011	-	6.067	12.000	228.7 1584 T.	.0065	

NOTES:

TABLE 200: DATA FOR LIFE LINES

<b>Date:</b>	11/13/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	.050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CTANR-164
		<b>Insert:</b>	TNMG-433

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
8	KC-910	340	.001	-	6.087	12.900	246.6 1831 T.	.007	
9	KC-910	340	.011	-	6.087	12.000	229.5 2060 T.	.007	
				PROJECTILE HARDNESS - 340			BHN.		
10	KC-910	340	.011	-	6.060	12.700	241.8 2302 T.	.0075	
11	KC-910	340	.011	-	6.060	12.000	228.4 2520 T.	.0075	
				PROJECTILE HARDNESS - 364			BHN.		
12	KC-910	340	.011	-	6.100	12.900	247.2 2777 T.	.0075	
13	KC-910	340	.011	-	6.100	12.000	230 3007 T.	.008	
				PROJECTILE HARDNESS - 340			BHN.		
14	KC-910	340	.011	-	6.070	24.600	469.1 3476 T.	.009	

**NOTES:**

**TABLE 201: DATA FOR LIFE LINES**

<b>Date:</b> 11/13/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> TOP				<b>Holder:</b> CTANR-164			
				<b>Insert:</b> TNMG-433			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
15	KC-910	340	.011	-	6.157	12.000	232.1 3708 T	.009	
16	KC-910	340	.011	-	6.157	6.000	116 3824 T	.010	
17	KC-910	340	.011	-	6.157	6.000	116 3940	.016	
				PROJECTILE HARDNESS - 340			BHN.		
1	KC-910	500	.011	-	6.053	4.800	91.3	.0045	
1a	KC-910	500	.011	-	6.053	9.500 T	.181 T.	.006	
1b	KC-910	500	.011	-	6.053	15.500 T	.295 T.	.007	380 .009
1	KC-910	650	.011	-	6.053	6.000	114 T.	.007	146 .009

**NOTES:**

**TABLE 202: DATA FOR LIFE LINES**  
277

<b>Date:</b> 11/20/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-820	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387			BHN.		
1	G-30	590	.011	-	6.127	12.800	246.4	.003 W. .0045 F.	NOTE 1
2	G-30	590	.011	-	6.127	12.000	230.9 477 T.	.005 W. .007 F.	
				PROJECTILE HARDNESS - 387			BHN.		
3	G-30	590	.011	-	6.120	24.300	467 944 T.	.010	NOTE 2
				PROJECTILE HARDNESS - 387			BHN.		
4	G-30	590	.011	-	6.061	24.400	464.6 1408 T.	.015	
				PROJECTILE HARDNESS - 387			BHN.		
5	G-30	590	.011	-	6.060	12.700	241.8 1650 T.	.016	
6	G-30	590	.011	-	6.060	12.000	228.6 1879 T.	.016	
				PROJECTILE HARDNESS - 375			BHN.		
7	G-30	590	.011	-	6.079	12.100	231 2110 T.	.017	
8	G-30	590	.011	-	6.079	12.000	229 2339 T.	.0175	

**NOTES:**

"W" - Wear-land at "edge of work" area.  
 "F" - Wear-land at flank.

1. Small chip in flank cutting area - not in "edge of work" area.
2. Maximum wear-land is in area where chip-out was.

TABLE 203: DATA FOR LIFE LINES

<b>Date:</b> 11/23/81				<b>Material:</b> HF-1			
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> NONE			
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>			
<b>Coolant Application:</b> NONE				<b>Holder:</b> CCCNR-164			
				<b>Insert:</b> CNG-454-820			

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 387			BHN.		
9	G-30	590	.011	-	6.082	12.700	242.6 2582 T.	.0175	
10	G-30	590	.011	-	6.082	12.000	229 2811	.018	
	NEW INSERT			PROJECTILE HARDNESS - 351			BHN.		
1	G-30	590	.011	-	6.082	12.800	244.6	.0045	
2	G-30	590	.011	-	6.082	11.200	214 459 T.	.007	
				PROJECTILE HARDNESS - 332			BHN.		
3	G-30	590	.011	-	6.095	24.500	469 928 T.	.008	
				PROJECTILE HARDNESS - 340			BHN.		
4	G-30	590	.011	-	6.098	24.800	475 1403 T.	.0115	
				PROJECTILE HARDNESS - 340			BHN.		
5	G-30	590	.011	-	6.093	24.200	463 1866	.015	

**NOTES:**

**TABLE 204: DATA FOR LIFE LINES**



[illegible]

**TABLE 205: DATA FOR LIFE LINES**



<b>Date:</b> 11/24/81		<b>Material:</b> HF-1	
<b>Depth of Cut:</b> APPROX. .050"		<b>Coolant:</b> NONE	
<b>Hardness:</b> SEE TAB		<b>Tool Description:</b>	
<b>Coolant Application:</b> NONE		<b>Holder:</b> CCGNR-164	
		<b>Insert:</b> CNG-454-630	

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 321 BHN.					
1	G-30	590	.011	-	6.075	12.800	244	.006	NOTE 1
2	G-30	590	.011	-	6.075	12.000	229 473 T.	.0085	
				PROJECTILE HARDNESS - 269 BHN.					
3	G-30	590	.011	-	6.126	12.800	246 719 T.	.011	NOTE 2
4	G-30	590	.011	-	6.126	12.000	231 950 T.	.0125	NOTE 3
	NEW INSERT			PROJECTILE HARDNESS - 321 BHN.					
1	G-30	590	.011	-	6.076	13.100	250	.006	
2	G-30	590	.011	-	6.076	11.300	216 466 T.	.0085	
				PROJECTILE HARDNESS - 286 BHN.					
3	G-30	590	.011	-	6.087	12.500	239 705 T.	.010	
4	G-30	590	.011	-	6.087	12.000	229.5 934 T.	.0105	

**NOTES:**

- .0185 deep notch in nose.
- Nose area breaking down.
- .025 deep notch in nose - test stopped.

TABLE 206: DATA FOR LIFE LINES

<b>Date:</b>	11/24/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	NONE
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	NONE	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA - IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 286 BHN.		
5	G-30	590	.011	-	6.044	24.700	469 1403	.011	
							PROJECTILE HARDNESS - 302 BHN.		
6	G-30	590	.011	-	6.084	24.200	463 1866 T.	.0125	
							PROJECTILE HARDNESS - 302 BHN.		
7	G-30	590	.011	-	6.081	24.200	462 2328 T.	.0145	
							PROJECTILE HARDNESS - 302 BHN.		
8	G-30	590	.011	-	6.156	12.100	234 2562 T.	.015	
9	G-30	590	.011	-	6.156	11.800	228 2790	.0155	
							PROJECTILE HARDNESS - 302 BHN.		
10	G-30	590	.011	-	6.067	13.000	248 3038 T.	.017	

NOTES:

TABLE 207: DATA FOR LIFE LINES

<b>Date:</b> 11/25/81	<b>Material:</b> HF-1
<b>Depth of Cut:</b> APPROX. .050"	<b>Coolant:</b> NONE
<b>Hardness:</b> SEE TAB	<b>Tool Description:</b>
<b>Coolant Application:</b> NONE	<b>Holder:</b> CCGNR-164
	<b>Insert:</b> CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 302 BHN.					
1	G-30	590	.011	-	6.067	11.200	213	.005	
				PROJECTILE HARDNESS - 302 BHN.					
2	G-30	590	.011	-	6.074	12.800	244 457 T.	.008	
3	G-30	590	.011	-	6.074	12.000	229 686 T.	.010	
				PROJECTILE HARDNESS - 302 BHN.					
4	G-30	590	.011	-	6.062	24.000	457 1143 T.	.0125	
				PROJECTILE HARDNESS - 387 BHN.					
5	G-30	590	.011	-	6.067	24.800	473 1616 T.	.0145	
				PROJECTILE HARDNESS - 364 BHN.					
6	G-30	590	.011	-	6.066	24.000	457 2073	.0165	
				PROJECTILE HARDNESS - 364 BHN.					
7	G-30	590	.011	-	6.089	24.200	463 2536	.0175	

**NOTES:**

**TABLE 208: DATA FOR LIFE LINES**



<b>Date:</b> 11/30/81				<b>Material:</b> HF-1					
<b>Depth of Cut:</b> APPROX. .050"				<b>Coolant:</b> TRIM-SOL 20:1					
<b>Hardness:</b> SEE TAB				<b>Tool Description:</b>					
<b>Coolant Application:</b> TOP				<b>Holder:</b> CCGNR-164					
				<b>Insert:</b> CNG-454-630					

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURND DIAMETER	TURND LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 364			BHN.		
1	G-10	610	.011	-	6.061	12.200	232.3	.004	
2	G-10	610	.011	-	6.061	11.700	222.8 455 T.	.007	
				PROJECTILE HARDNESS - 364			BHN.		
3	G-10	610	.011	-	6.090	12.900	246.8 702 T.	.0085	
4	G-10	610	.011	-	6.090	11.200	214.3 916 T.	.010	
				PROJECTILE HARDNESS - 340			BHN.		
5	G-10	610	.011	-	6.070	23.700	452 1368 T.	.0115	
				PROJECTILE HARDNESS - 387			BHN.		
6	G-10	610	.011	-	6.133	22.800	439.3 1807 T.	.013	NOTE 1
				PROJECTILE HARDNESS - 364			BHN.		
7	G-10	610	.011	-	6.095	22.500	430.8 2238 T.	.015	

**NOTES:**  
1. Chip condition 1/4" diameter curl - single roll.

TABLE 210: DATA FOR LIFE LINES







<b>Date:</b>	11/30/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA -- IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 321			BHN.		
1	G-10	610	.011	-	6.054	12.800	243.4	.0045	
2	G-10	610	.011	-	6.054	12.000	228.2 472 T.	.0075	
				PROJECTILE HARDNESS - 321			BHN.		
3	G-10	610	.011	-	6.089	13.00	248.7 721 T.	.0105	
4	G-10	610	.011	-	6.089	11.200	214.2 935 T.	.012	
				PROJECTILE HARDNESS - 321			BHN.		
5	G-10	610	.011	-	6.071	23.800	453.9 1389 T.	.015	NOTE 1

**NOTES:**  
 1. Too large an increase in wear-land rate - test stopped.

**TABLE 212: DATA FOR LIFE LINES**

<b>Date:</b>	12/1/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCGNR-164
		<b>Insert:</b>	CNG-454-630

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 321			BHN.		
1	G-10	550	.011	-	6.059	13.100	249.4	.004	NOTE 1
2	G-10	550	.011	-	6.059	12.800	243.6 493 T.	.0065	
				PROJECTILE HARDNESS - 340			BHN.		
3	G-10	550	.011	-	6.078	13.100	250.1 743 T.	.009	
4	G-10	550	.011	-	6.078	10.900	208.1 951 T.	.011	
				PROJECTILE HARDNESS - 340			BHN.		
5	G-10	550	.011	-	6.062	23.600	449.4 1400 T.	.014	NOTE 2

**NOTES:**  
 1. Chip condition 1/2" diameter roll - 6" to 8" long.  
 2. Too large an increase in wear-land rate - test stopped.

**TABLE 213: DATA FOR LIFE LINES**

<b>Date:</b> 12/1/81 <b>Depth of Cut:</b> APPROX. .050" <b>Hardness:</b> SEE TAB <b>Coolant Application:</b> TOP	<b>Material:</b> HF-1 <b>Coolant:</b> TRIM-SOL 20:1 <b>Tool Description:</b> <b>Holder:</b> CCGNR-164 <b>Insert:</b> CNG-454-820
---	--

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
				PROJECTILE HARDNESS - 340			BHN.		
1	G-10	550	.011	-	6.105	13.000	249.3	.0035	
2	G-10	550	.011	-	6.105	9.500	182.2 432 T.	.0055	
				PROJECTILE HARDNESS - 340			BHN.		
3	G-10	550	.011	-	6.069	12.800	244 676 T.	.006	
4	G-10	550	.011	-	6.069	12.000	228.8 905 T.	.007	
				PROJECTILE HARDNESS - 340			BHN.		
5	G-10	550	.011	-	6.054	24.100	458 1363 T.	.008	
				PROJECTILE HARDNESS - 340			BHN.		
6	G-10	550	.011	-	6.096	13.100	250.9 1614 T.	.009	
7	G-10	550	.011	-	6.096	12.000	229.8 1844 T.	.0095	

**NOTES:**

**TABLE 214: DATA FOR LIFE LINES**

<b>Date:</b>	12/1/81	<b>Material:</b>	HF-1
<b>Depth of Cut:</b>	APPROX. .050"	<b>Coolant:</b>	TRIM-SOL 20:1
<b>Hardness:</b>	SEE TAB	<b>Tool Description:</b>	
<b>Coolant Application:</b>	TOP	<b>Holder:</b>	CCG NR-164
		<b>Insert:</b>	CNG-454-820

RUN NO.	CARBIDE GRADE	CUTTING SPEED-FT/MIN.	FEED IN./REV.	ROUGH DIAMETER	TURNED DIAMETER	TURNED LENGTH	MACHINED AREA — IN <sup>2</sup>	WEAR-LAND INCH	IN <sup>2</sup> OF MACHINED SURFACE AT INCHES OF WEAR-LAND
							PROJECTILE HARDNESS - 364 BHN.		
8	G-10	550	.011	-	6.109	24.200	464.4 2308 T.	.011	
							PROJECTILE HARDNESS - 364 BHN.		
9	G-10	550	.011	-	6.053	24.000	456.4 2764 T.	.013	
							PROJECTILE HARDNESS - 364 BHN.		
10	G-10	550	.011	-	6.071	24.800	473 3237 T.	.015	
							PROJECTILE HARDNESS - 340 BHN.		
11	G-10	550	.011	-	6.063	24.300	462.8 3700 T.	.017	

**NOTES:**

**TABLE 215: DATA FOR LIFE LINES**

**TABLE OF TOOL LOADS IN POUNDS VERSUS DEPTHS OF  
CUT IN INCHES FOR THE FOLLOWING TOOL MATERIALS  
OPERATING UNDER LISTED CONDITIONS.**

**MATERIAL:** HF-1

**HARDNESS:** 364 BHN.

**INSERT:** TNMG-433

**SURFACE FEED:** 340

**COOLANT:** TRIM-SOL

FT./MIN. 20:1 TOP APPLICATION

**GRADE:** KC-910

**FEEDRATE:** .011 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	120	40	80
.050	230	110	110
.100	430	200	140
.150	600	300	160

**INSERT:** CNG-454  
.008 X 20°

**SURFACE FEED:** 550

**COOLANT:** TRIM-SOL

FT./MIN. 20:1 TOP APPLICATION

**GRADE:** G-10

**FEEDRATE:** .011 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	120	50	100
.050	220	110	130
.100	420	230	160
.150	600	340	180

**INSERT:** CNG-454  
.006 X 30°

**SURFACE FEED:** 590

**COOLANT:** NONE

FT./MIN.

**GRADE:** G-30

**FEEDRATE:** .011 IN./REV.

DEPTH OF CUT	TANGENTIAL TOOL LOAD	FEED TOOL LOAD	RADIAL TOOL LOAD
.025	120	60	140
.050	220	120	180
.100	410	260	210
.150	600	400	230

**TABLE 216: DATA FOR TOOL LOAD CHARTS**



### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** HF-1

**HOLDER:** CTANR-164

**HARDNESS:** 364 BHN.

**INSERT:** TNMG-433

**SURFACE SPEED:** 340 FT./MIN.

**GRADE:** KC-910

**FEED RATE:** .011 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP

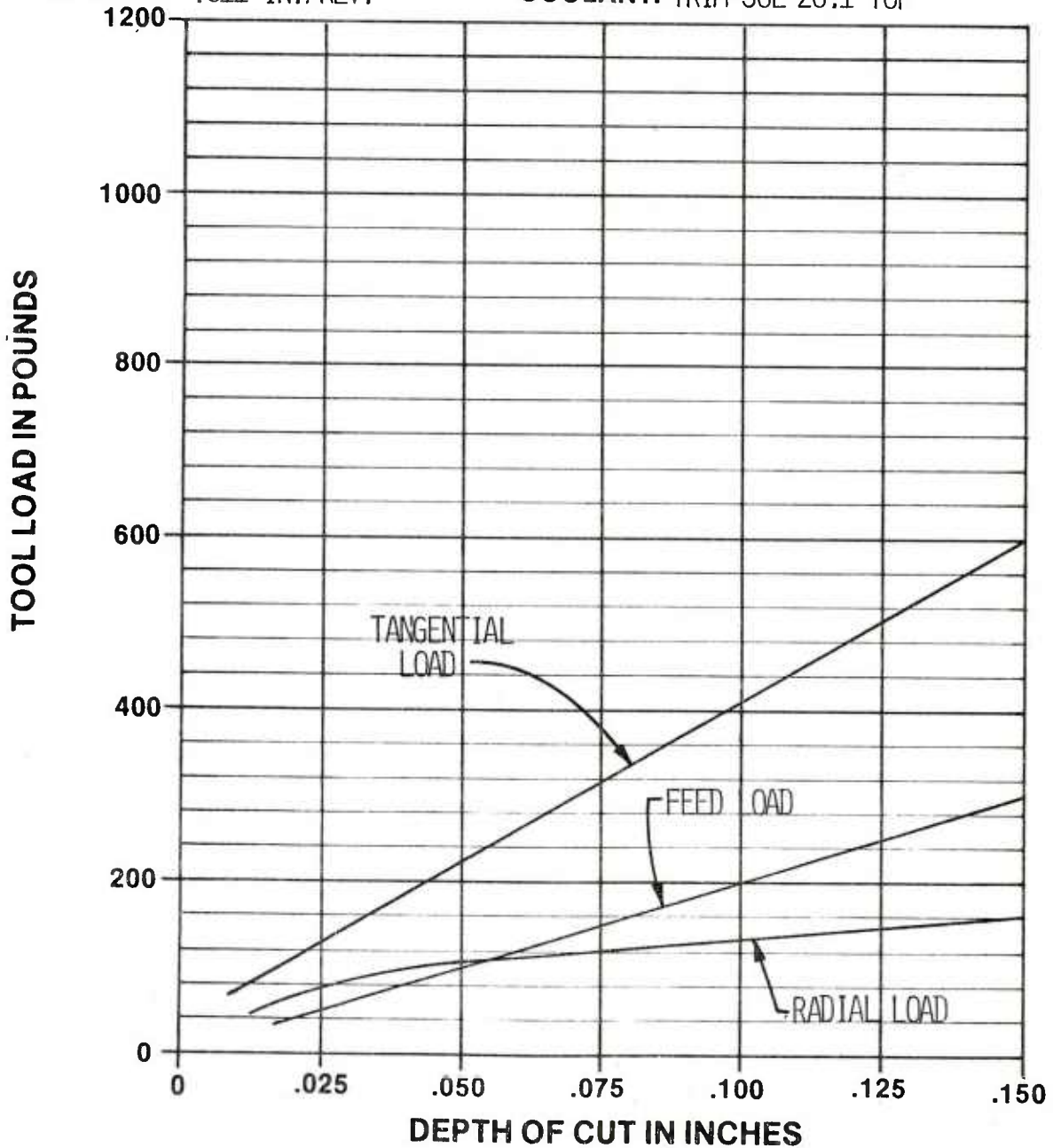


FIGURE 56: TOOL LOAD CHART



### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** HF-1

**HOLDER:** CCGNR-164

**HARDNESS:** 364 BHN.

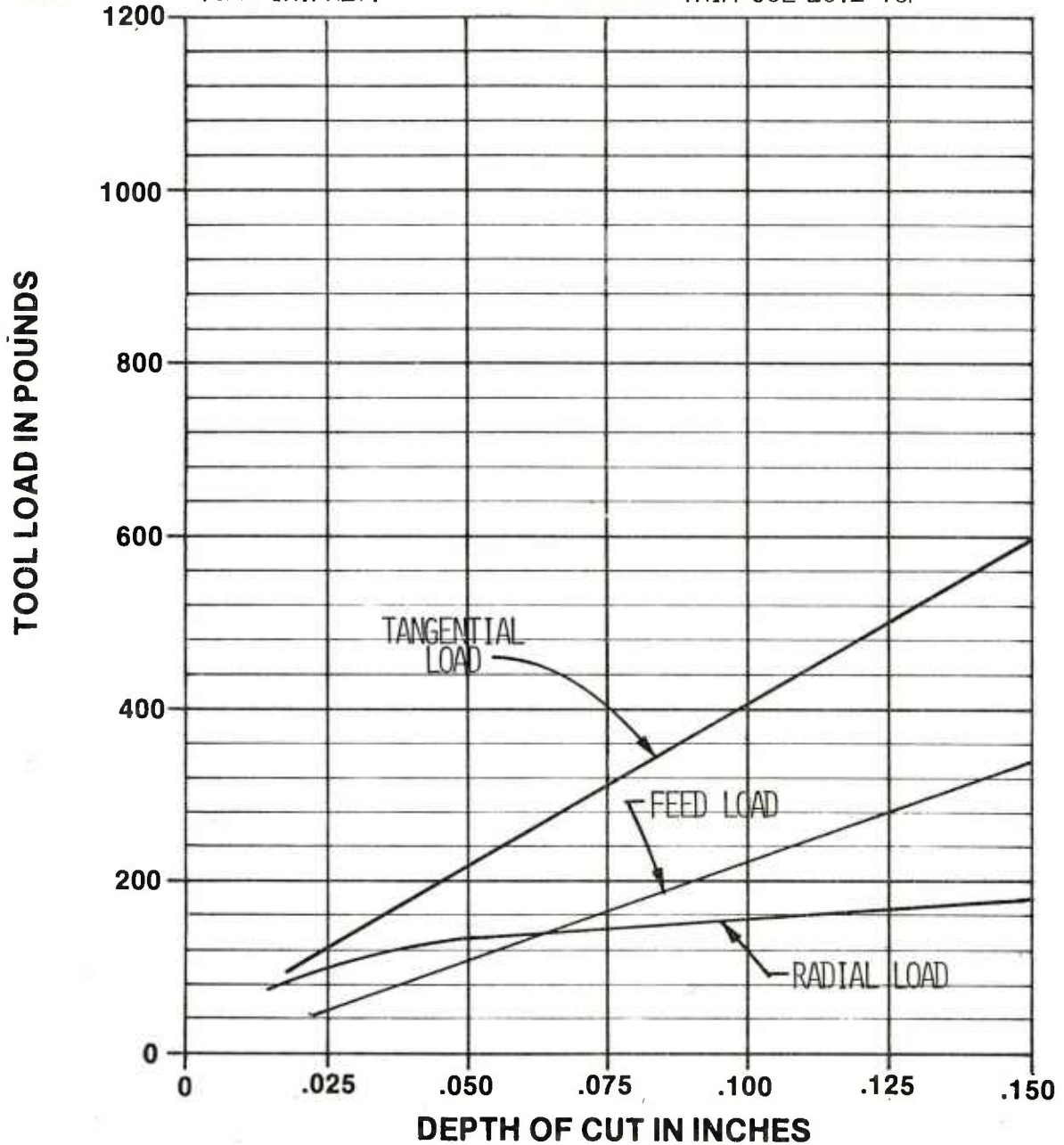
**INSERT:** CNG-454-820

**SURFACE SPEED:** 550 FT./MIN.

**GRADE:** G-10

**FEED RATE:** .011 IN./REV.

**COOLANT:** TRIM-SOL 20:1 TOP



**FIGURE 57: TOOL LOAD CHART**

### TOOL LOAD VERSUS DEPTH OF CUT

**MATERIAL:** HF-1

**HOLDER:** CCGNR-164

**HARDNESS:** 364 BHN.

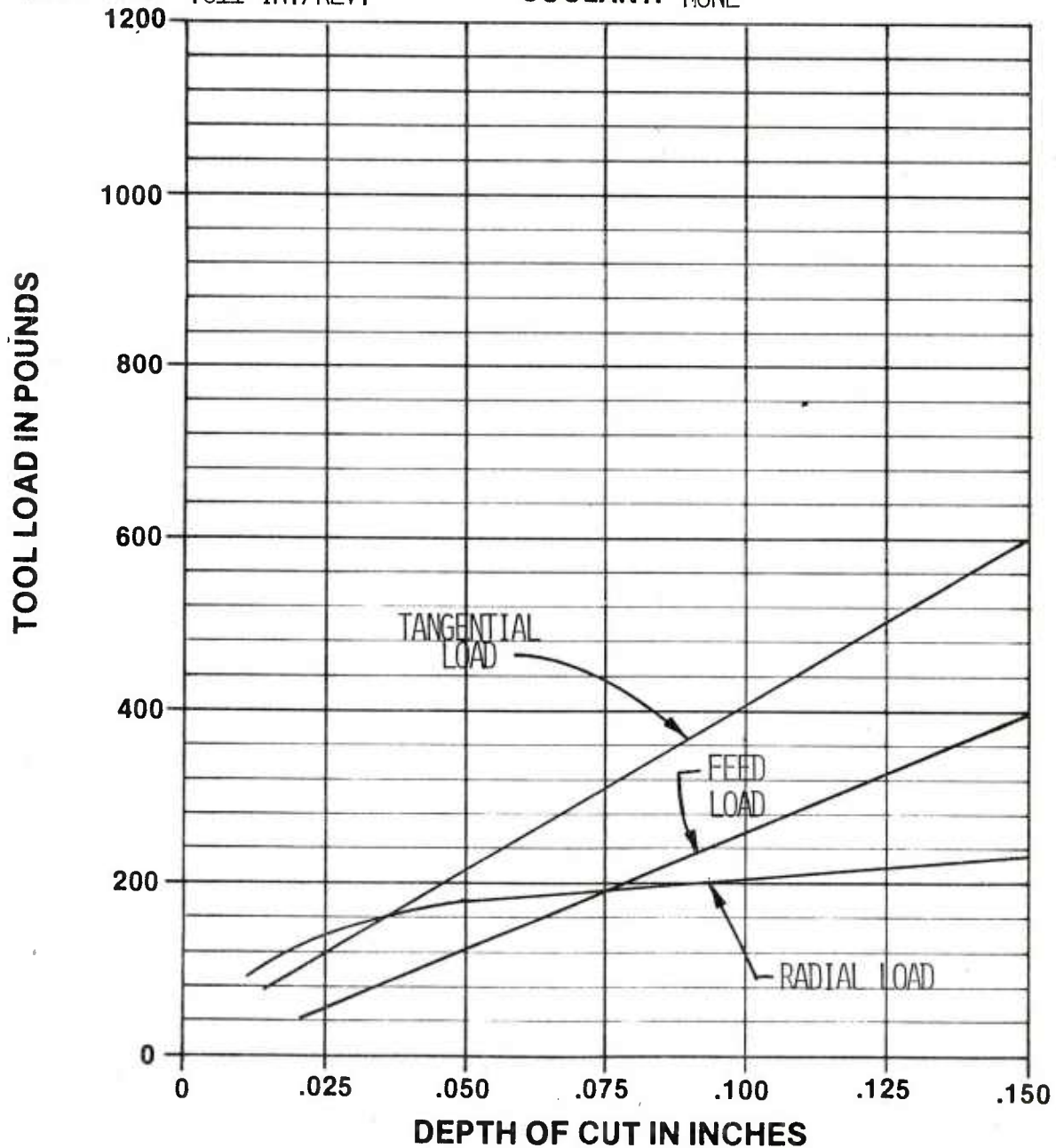
**INSERT:** CMG-454-630

**SURFACE SPEED:** 590 FT./MIN.

**GRADE:** G-30

**FEED RATE:** .011 IN./REV.

**COOLANT:** NONE



**FIGURE 58: TOOL LOAD CHART**

**Conclusions:**

1. Significant increases in metal removal rates for heat-treated steels can be obtained using ceramic cutting tools as compared with the reference ceramic coated tungsten carbide cutting tools.
2. Ceramic tools and ceramic-coated tungsten carbide tools show equivalent tool life when machining steels in the "as forged" condition.
3. Optimum cutting tool life requires infinite spindle speed control thru the usable range.
4. Higher cutting speeds require higher horsepower machines.

**Recommendations:**

1. The use of ceramic cutting tools should be considered for all machining operations.
2. When ceramic cutting tools are used, the tool holders should be designed to accept thicker inserts, have a stable insert pocket, and have a low profile, rugged clamping device.
3. Variable spindle speed control is important for optimum tool life when machining the "as forged" steel and is of paramount importance when machining the heat-treated steels.
4. Feed control, so a consistent tool load can be maintained, throughout all tool paths is required when applying ceramic cutting tools, and would give better tool life when using tungsten carbide tools.
5. The results on the heat-treated 4340 material was inconclusive when ceramic cutting tools were tested and further effort should correct this deficiency.

APPENDIX A  
CHEMICAL COMPOSITION AND MICROGRAPHS OF MATERIALS

**CHEMICAL ANALYSIS  
COMPOSITION (%)**

<b>Element</b>	<b>MATERIAL</b>			
	<b>AISI-1340</b>	<b>AISI-4140</b>	<b>AISI-4340</b>	<b>HFI</b>
Carbon	.38	.42	.43	1.09
Manganese	1.70	.86	.79	1.86
Phosphorous	.018	.012	.016	.015
Sulfur	.028	.025	.019	.019
Silicon	.34	.20	.31	.83
Chromium	----	1.03	.81	----
Molybdenum	----	.20	.24	----
Nickel	----	----	1.84	----
Other elements	None detected	None detected	None detected	None detected

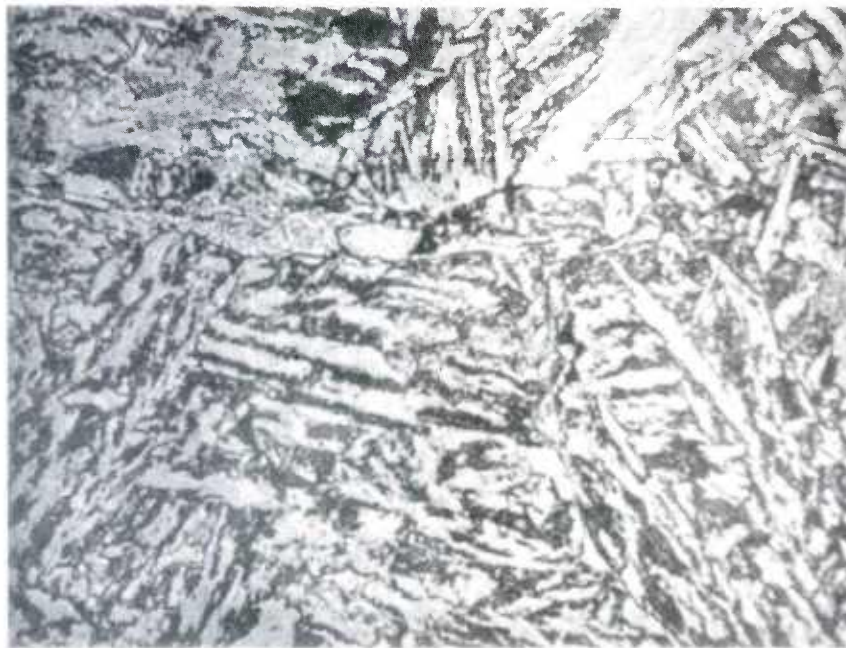
According to the above test results, samples 1340, 4140 and 4340 conform to their respective requirements for AISI steels. No specification was given for HF-1 material.

The chemical analysis of the above materials and the following photomicrographs of the material structures were done at the Massachusetts Materials Research Inc., 241 W. Boylston Street, West Boylston, Massachusetts.

**Metallographic Sample**  
**AISI-1340 "Rough" - 255 Bhn. (25 Rc)**



100X



1000X

The photomicrograph showed a microstructure typical of tempered martensite.



**Metallographic Sample**  
**AISI-1340 - "Finish" - 340 Bhn. (36 Rc)**



100X



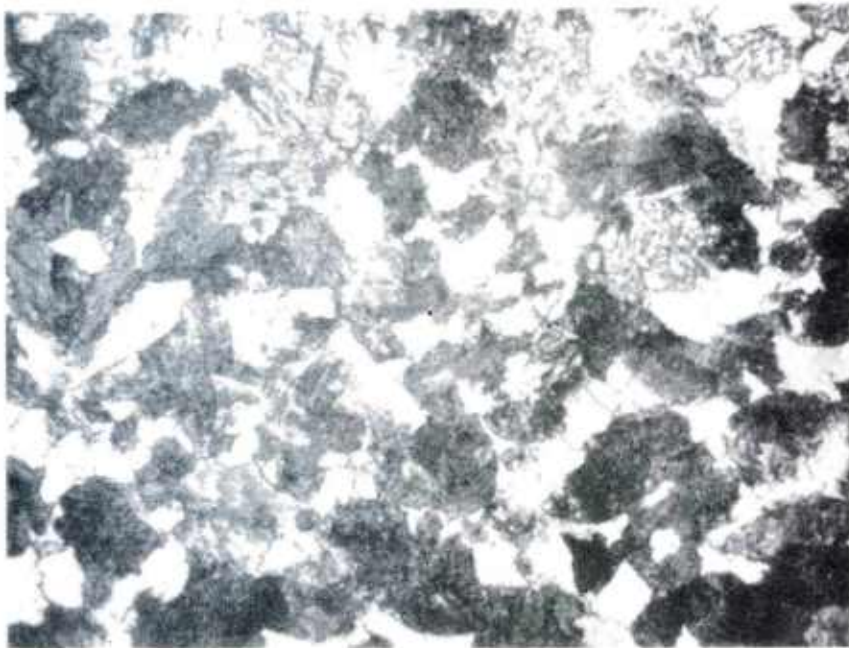
1000X

The microstructure consisted of tempered martensite.

**Metallographic Sample**  
**AISI-4140 "Rough" - 187 Bhn. (12 Rc)**



100X



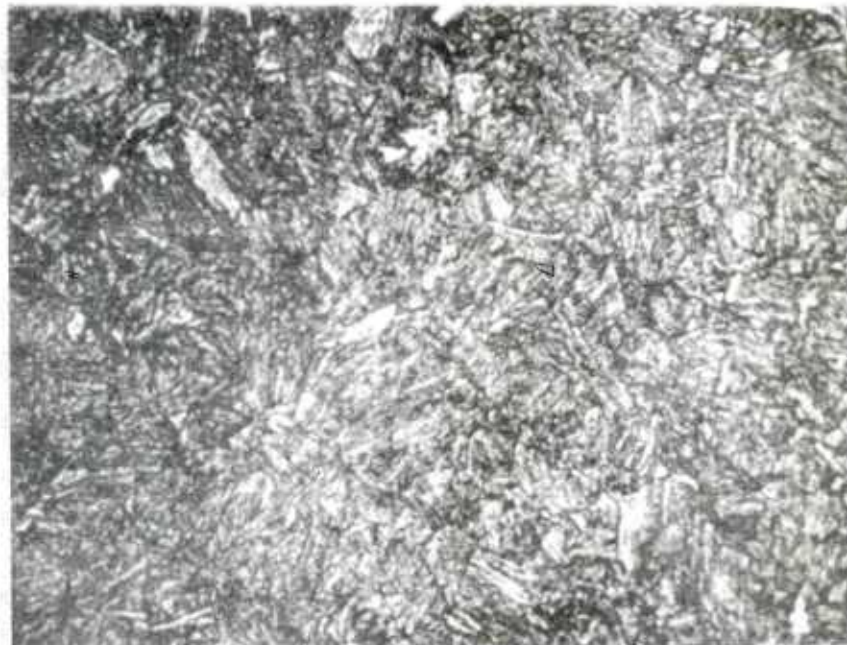
1000X

The microstructure consisted of fine equiaxed pearlite and ferrite.

**Metallographic Sample**  
**AISI-4140 - "Finish" - 387 Bhn. (41 RC)**



100X

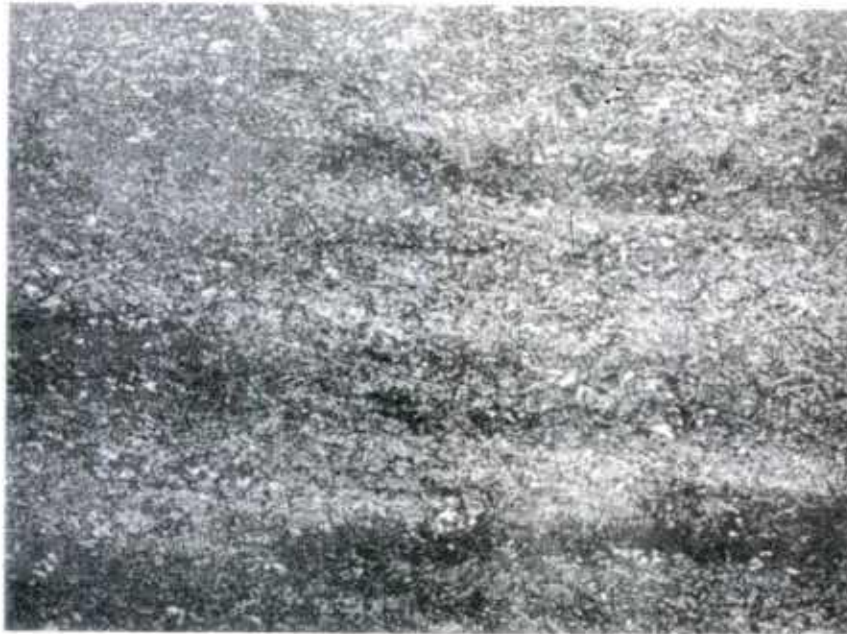


1000X

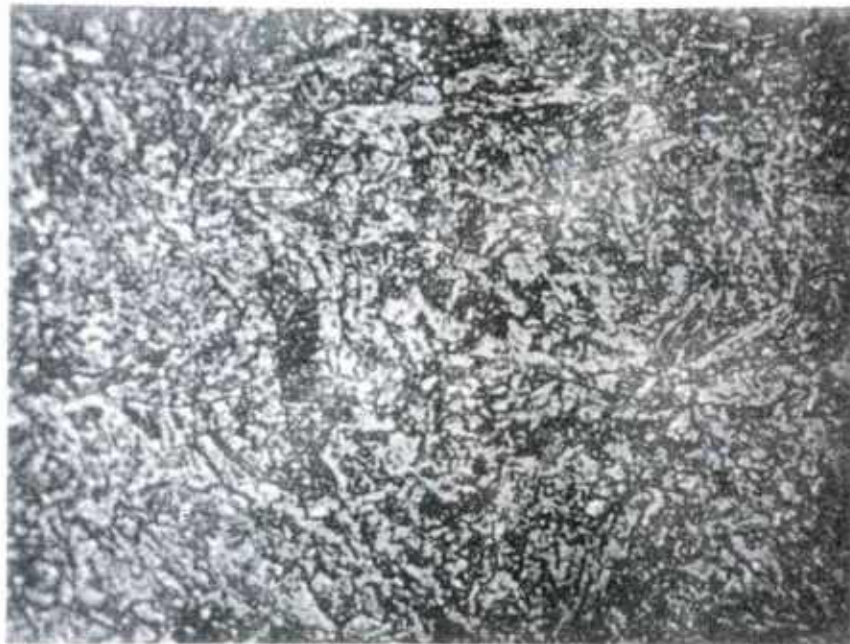
The microstructure consisted of tempered martensite with some ferrite.



**Metallographic Sample**  
**AISI-4340 "Rough" - 241 Bhn. (23 Rc)**



100X



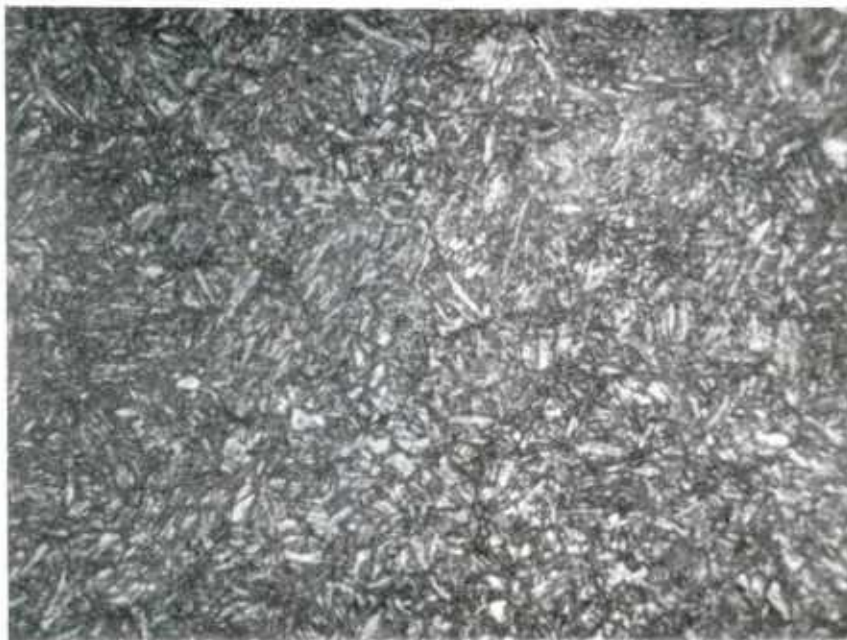
1000X

The microstructure consisted of fine tempered martensite.

**Metallographic Sample**  
**AISI-4340 - "Finish" - 388 Bhn (41 Rc)**



100X



1000X

The microstructure consisted of tempered martensite

**Metallographic Sample**  
**HF-1- "Rough" 255 Bhn. (25 Rc)**



100X



1000X

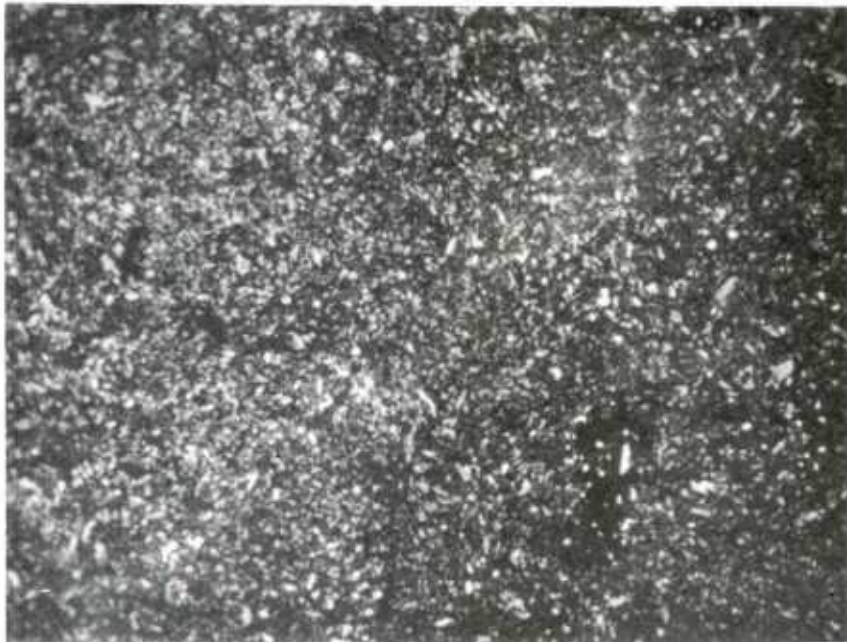
The microstructure consisted of fine lamellar pearlite with some ferrite present.



**Metallographic Sample**  
**HF-1 - "Finish" - 364 Bhn. (38 Rc)**



100X



1000X

The microstructure consisted of fine tempered martensite and spheroidal cementite particles.

APPENDIX B  
CHIP-BREAKER DESIGN

Following is a method to determine the angle of chip-flow when machining "finishing" cuts. When the angle of chip-flow is found, then a chip-breaker can be placed perpendicular to the chip-flow, so chips will curl with the minimum amount of energy and heat. In this study no effort was made to establish the width of the chip-breaker, but when using ceramic inserts, the breaker should be as wide as possible, so the friction heat of the chip is as far from the nose radius as possible.

Chart showing angle of chip-flow (a) for various nose radii, depths of cut, and feed rates.

Depth of Cut "D"

Nose Radius - .03125"

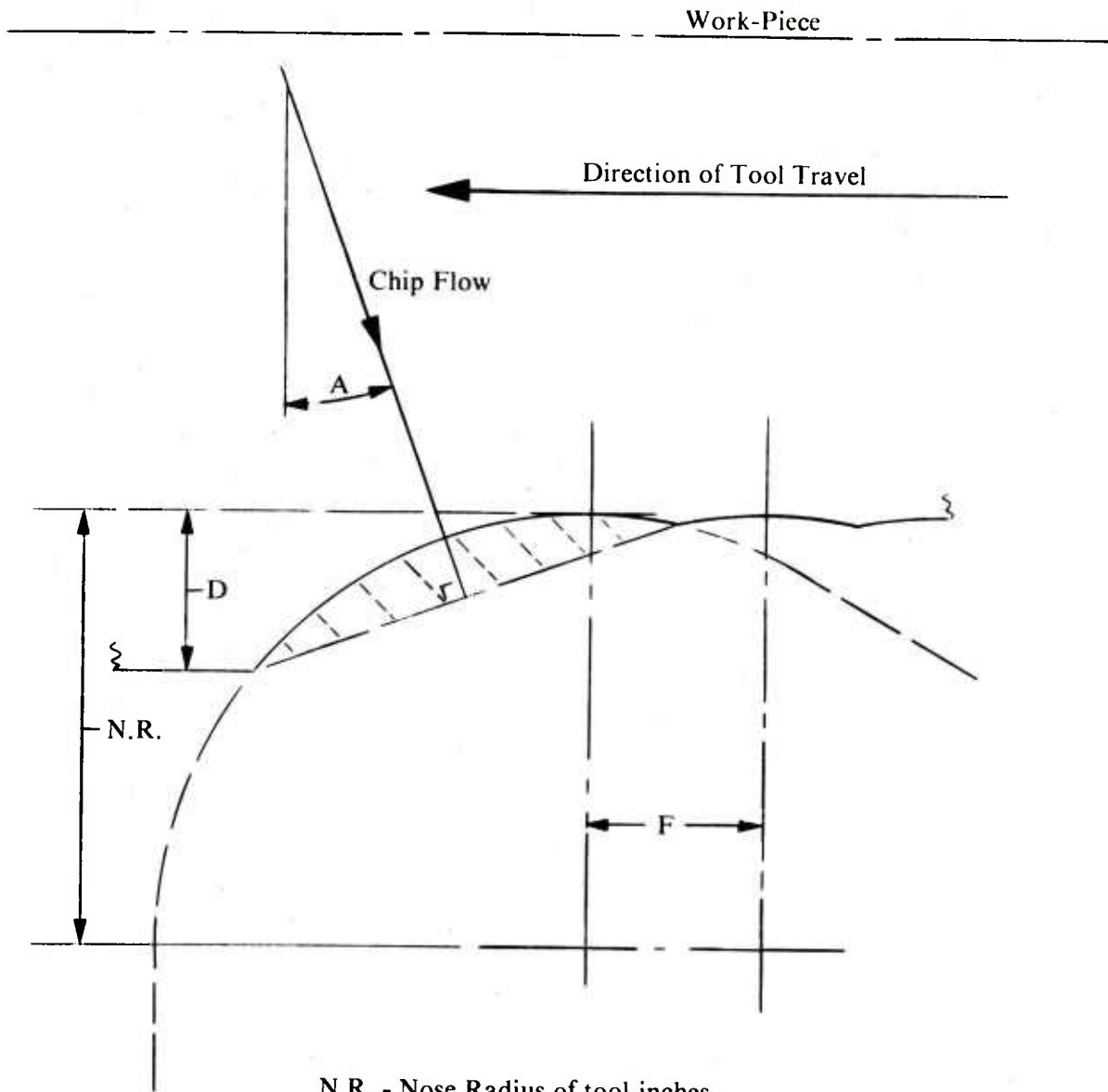
Feed In./Rev.	.020	.030
.010	29.8°	39.3°
.014	28.0°	37.4°
.018	26.1°	35.5°
.022	24.1°	33.5°
.026	22.2°	31.6°

Nose Radius - .0468"

Feed In./Rev.	.020	.030	.040
.010	24.4°	31.4°	37.7°
.016	22.6°	29.5°	35.9°
.022	20.7°	27.7°	34.0°
.028	18.8°	25.8°	32.1°

Nose Radius - .0625"

Feed In./Rev.	.020	.030	.040	.050	.060
.010	21.3°	27.0°	32.2°	39.9°	41.6°
.018	19.4°	25.2°	30.3°	35.1°	39.7°
.026	17.6°	23.3°	28.4°	33.2°	37.9°
.030	16.6°	22.4°	27.4°	32.3°	36.9°



N.R. - Nose Radius of tool-inches

D. - Depth of Cut - inches

F. - Feed-inches per revolution

A. - Angle of Chip-flow

DISTRIBUTION LIST

Commander  
U.S. Army Armament Research  
and Development Command  
ATTN: DRDAR-LCU-M (5)  
DRDAR-SF (5)  
DRDAR-TSS (5)  
Dover, NJ 07801

Commander  
U.S. Army Munitions Production Base  
Modernization Agency  
ATTN: SARPM-PBM-MA (5)  
Dover, NJ 07801

Commander  
Scranton Army Ammunition Plant (2)  
Scranton, PA 18501

Commander  
Louisiana Army Ammunition Plant (2)  
Shreveport, LA 71130

Commander  
Riverbank Army Ammunition Plant (2)  
Riverbank, CA 95367

Contract Administrator  
Chamberlain Manufacturing Co.  
New Bedford, MA 02745

Contract Administrator  
National Presto Industries  
Eau Claire, WI 54701

Contract Administrator  
Norris Industries  
Vernon, CA 90058

Contract Administrator  
Lansdowne Steel & Iron  
Morton, PA 19070

Contract Administrator  
Ferrulmatic, Inc.  
Paterson, NJ 07509

Contract Administrator  
Flinchbaugh Products Inc.  
Red Lion, PA 17356



Contract Administrator  
Chamberlain Manufacturing Co.  
Waterloo, IA 50704

Contract Administrator  
Martin-Marietta  
Orlando, FL 32855

Commander  
Mississippi Army Ammunition Plant (2)  
Picayune, MS 39466

Administrator  
Defense Technical Information Center  
ATTN: Accessions Division (12)  
Cameron Station  
Alexandria, VA 22314

Director  
U.S. Army Materiel Systems  
Analysis Activity  
ATTN: DRXSY-MP  
Aberdeen Proving Ground, MD 21005

Commander/Director  
Chemical Systems Laboratory  
U.S. Army Armament Research  
and Development Command  
ATTN: DRDAR-CLB-PA  
DRDAR-CLJ-L  
APG, Edgewood Area, MD 21010

Director  
Ballistic Research Laboratory  
U.S. Army Armament Research  
and Development Command  
ATTN: DRDAR-TSB-S  
Aberdeen Proving Ground, MD 21005

Chief  
Benet Weapons Laboratory, LCWSL  
U.S. Army Armament Research  
and Development Command  
ATTN: DRDAR-LCB-TL  
Watervliet, NY 12189

Commander  
U.S. Army Armament Materiel  
Readiness Command  
ATTN: DRSAR-LEP-L  
Rock Island, IL 61299

Director  
Industrial Base Engineering Activity  
ATTN: DRXIB-MT  
Rock Island, IL 61299